Weeds

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Table of Contents

	Page
Editorial	104
The Effect of 2,4-D on the Yield and Botanical Composition of Ladino Clover-Orchard Grass Pasture by Ellis W. Hauser, W. C. Shaw, D. S. Chamblee, and W. W. Woodhouse, Jr	105
Preliminary Studies in the Use of Herbicides for the Control of Weeds in Sansevieria by Edward O. Gangstad, Charles C. Seale, and J. Frank Joyner	113
The Influence of Soil Type on the Selective Action of Chloro-IPC and Sodium TCA by Roger Blouch and Jess Fults	119
Weed Populations as Related to Certain Cultivated Crops in the Connecticut River Valley, Mass. by Jonas Vengris	125
A Synthesis of C^{14} Carbonyl Labeled 3-(Parachlorophenyl)-1, 1-Dimethyl-urea by Albert V. Logan and Norman R. Odell	135
The Effects of Fresh Water Storage on the Germination of Certain Weed Seeds. I. White top, Russian knapweed, Canada thistle, morning glory, and poverty weed by V. F. Bruns and W. L. Rasmussen	138
Effect of 2,4-D Sprays on the Growth of Young Sugar Cane by John R. Havis	148
Comments: A Theory for the Selective Mechanism of Chloro IPC by S. K. Ries	155
Bibliography of Weed Investigations October, November, December, 1952	159

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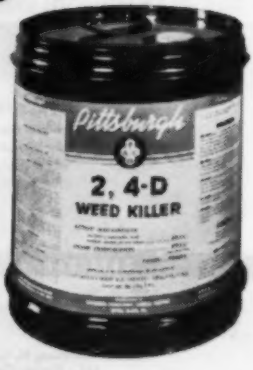

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National Weed Meeting

The first meeting of the Association of Regional Weed Control Conferences will take place in the Municipal Auditorium, Kansas City, December 8 and 9, 1953, one day prior to the meeting of the North Central Conference which is host.

The program committee (E. P. Sylvester of Iowa, C. E. Minarik of Camp Detrick, and R. L. Lovvorn of the U.S.D.A.) are hard at work on details. In general, the two days will be divided between general sessions on basic problems in Research, Education, and Regulation and separate sessions running concurrently on more specific aspects such as Brush Control, Weeds in Horticultural Crops, Weeds and Public Health, etc.

Although many papers are not yet in as we go to the printers, enough are in hand to guarantee the success of this first meeting.

The Muehlebach Hotel is the Headquarters Hotel for the North Central Conference. There are several other good hotels in the vicinity of the Auditorium where the meetings will take place. Please address all inquiries regarding accommodations to "Housing Bureau, 1030 Baltimore Avenue, Kansas City 5, Missouri."

I am looking forward to meeting many "Weeders" at Kansas City.

Weeds Changing Editors

It is with pleasure that I can announce at this time that Dr. R. L. Lovvorn is succeeding me as Editor of *"Weeds."* He will carry on at least until the Kansas City meeting. I am sure that readers, authors, and advertisers will be better satisfied with this new arrangement because it affords a very good opportunity for the journal to get onto a more reasonable publication schedule.

It has been a most gratifying experience working with the Editorial Board and with all the committees and individuals who have helped to launch *"Weeds."* I am confident the journal has a bright future and am sorry that my other duties do not permit me to continue with a more active part in that future.

Thank you everyone for being so considerate of a struggling Editor.

Sincerely

ROBERT D. SWEET

Weeds

JOURNAL OF THE ASSOCIATION OF REGIONAL WEED CONTROL CONFERENCES.

VOLUME II APRIL 1953 NUMBER 2

The Effect of 2,4–D on the Yield and Botanical Composition of Ladino Clover-Orchard Grass Pasture[1]

ELLIS W. HAUSER,[2] W. C. SHAW,[3] D. S. CHAMBLEE[4] and W. W. WOODHOUSE, JR.[5]

INTENSIVE research in pastures and forage crops has stimulated an increased interest in grassland farming in the southern states. A great deal of emphasis has been given to the various phases of establishment and maintenance of permanent pastures. However, very little work has been reported on the possible use of chemicals for controlling weeds in grass-legume mixtures.

In North Carolina, Ladino clover-orchard grass and Ladino-fescue mixtures have been widely accepted by farmers. Between 1945 and 1950 over 800,000 acres of these pastures were sown. Perennial weeds, such as curled dock *(Rumex crispus)*, wild garlic *(Allium vineale)*, and horse nettle *(Solanum carolinense)* are serious problems in pasture maintenance.

Many annual weeds may be controlled by the use of proper cultural practices, such as the use of weed free seed, thorough seedbed preparation, adequate fertilization, timely and efficient mowing, and good grazing management. Perennial weeds, such as curled dock, however, are difficult or sometimes impossible to control economically even by practicing the most efficient cultural practices.

Herbicides, especially 2,4–dichlorophenoxyacetic acid (2,4–D), offer considerable promise for controlling weeds in pastures. In a chemical weed control program, it is always necessary to know the tolerance of the crop plants and weeds to the chemical. Several workers have reported on the relative tolerance of various legumes to 2,4–D (1, 2, 4, and 6).

The purpose of the study reported herein was to determine the

[1]Contribution from the Agronomy Department, North Carolina Agricultural Experiment Station, Raleigh, North Carolina. Published with the approval of the Director of Research as Paper No. 413 of the Journal Series.

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stage of growth or season in which Ladino clover-orchard grass pasture was most tolerant to 2,4–D, to determine the length of time required for recovery after treatment, to determine the effect of 2,4–D on the botanical composition of the pasture sward, and to compare the effects of several rates of an alkanolamine salt and isopropyl ester formulation of 2,4–D applied at four different times during the growing season on the yield of the mixture.

MATERIALS AND METHODS

The experimental area was located in a Ladino clover-orchard grass pasture on a Cecil clay loam soil in the Piedmont region near Raleigh, North Carolina. The pasture was seeded in 1947 and subsequently fertilized and managed according to North Carolina Extension Service recommendations (3). Uniformity of clover-grass distribution was the criterion for selecting the experimental area. A sparse stand of curled dock was present in the experimental area.

The experimental design was a randomized split plot with three replications. The chemically treated plots were 8 x 26 feet. An alkanolamine salt and an isopropyl ester formulation of 2,4–D* at 0, ⅛, ¼, ½, 1.0, and 2.0 pounds acid equivalent per acre were applied on April 10, June 15, August 15, and October 12, 1950. These dates of application were chosen in an attempt to determine the effect of 2,4–D on Ladino clover during different stages and rates of growth. The entire experimental area was then subdivided into four areas, 254 feet by 32 feet in size, which were chemically treated on the four different dates. Temporary fences were installed between the areas to be treated on different dates so as to obtain controlled grazing with dairy cattle prior to treatment.

The entire experimental area was grazed by dairy cattle until the Ladino clover averaged approximately 1 inch in height. The clover in the area designated for treatment on April 10 was allowed to recover to a height of approximately 2 inches prior to chemical treatment. The first harvest for each treatment date was made when the Ladino clover in the untreated check plots reached a height of 4–6 inches. Controlled grazing was practiced on the areas designated for treatment on June 10, August 15, and October 12 until approximately 10 days prior to the time of treatment. The clover was then grazed to 1 inch and allowed to recover to approximately 2 inches before treatment as was practiced in the area designated for treatment on April 10. Grazing was not practiced following the spray applications.

All spray applications were made with an experimental plot sprayer (5) which applied 10 gallons of spray mixture when operated at 30 psi, and 4 mph. Two parallel booms with staggered nozzles were used in order to obtain double coverage.

A cutter-bar type mower was used for sampling the plots. A swath 3 feet wide was removed from the end of each plot and discarded in order to minimize border effects. An area 3 feet by 20 feet was harvested from the center of each plot. A subsample, approximately 20

*Experimental quantities supplied by the Dow Chemical Company, Midland, Michigan.

percent of the harvested sample, was taken and botanical analyses were performed by the hand separation method. The remaining portions of the harvest samples were dried by using forced hot air circulation. After the subsamples were hand separated and dried, the separated samples and remaining unseparated samples were weighed. Percentage composition of the entire sample was computed on the basis of weights of the separated subsamples.

The first harvest following each date of application was hand separated. Second harvests for botanical separations were made on the areas treated in April, June, and August. The total yield of forage 20 weeks after treatment was determined by a third cutting on the areas treated in April and June. On April 19, 1951, a harvest for botanical analyses and yield determinations was taken from all plots treated in 1950.

A combined analysis of variance was completed on percent clover for all cuttings made 30 days after treatment. Statistical analyses were made on yield of clover and grass obtained at the April harvest in 1951.

RESULTS AND DISCUSSION

The effect of 2,4–D on the yield of Ladino clover following different dates of application may be determined by examining the data in tables 1, 2, 3, and 4. Rates up to 1 pound per acre of 2,4–D did not severely reduce the yield of Ladino clover following the June and August dates of treatment while rates greater than 1 pound per acre caused significant yield reductions as shown in tables 2 and 3. The data in tables 1 and 4 indicate that Ladino clover was much less tolerant to 2,4–D following the April and October than following the June and August treatments (tables 2 and 3). While Ladino clover was relatively tolerant to 2,4–D applied in June or August, rates as low as 1/8 pound per acre in April and 1/4 pound per acre in October caused significant yield reductions (tables 1, 2, 3, and 4).

Table 1. The effect of 2,4–D applied April 10, 1950 on the yield and botanical composition of a Ladino clover-orchard grass pasture.

Formulation	Rate per acre	First cutting 1950 30 days after treatment*		Second cutting 1950 90 days after treatment		First cutting April 1951 375 days after treatment	
		Yield per acre		Yield per acre		Yield per acre	
		Clover	Grass	Clover	Grass	Clover	Grass
		lbs.		lbs.		lbs.	
Isopropyl ester	0	400	1923	275	883	691	761
	1/8	133	1502	242	861	897	672
	1/4	91	2056	185	910	882	719
	1/2	150	1617	278	901	699	807
	1	67	1720	117	872	677	809
	2	43	1701	142	928	701	822
Alkanolamine salt	0	354	1716	365	895	913	608
	1/8	183	1510	269	834	703	786
	1/4	128	1430	220	795	844	634
	1/2	82	1539	185	1004	780	779
	1	50	1547	151	983	613	814
	2	2	1842	114	1017	841	627
L.S.D. (.05) =						N.S.	N.S.

*Analysis of variance was computed on per cent clover at this date. L.S.D. (.01) = 8.5%.

Table 2. The effect of 2,4–D applied June 15, 1950 on the yield and botanical composition of a Ladino clover-orchard grass pasture.

Formulation	Rate per acre	First cutting 1950 30 days after treatment*		Second cutting 1950 100 days after treatment		First cutting April 1951 300 days after treatment	
		Yield per acre		Yield per acre		Yield per acre	
		Clover	Grass	Clover	Grass	Clover	Grass
		lbs.		lbs.		lbs.	
Isopropyl ester	0	394	885	436	469	774	541
	⅛	493	847	567	343	826	525
	¼	352	738	455	416	901	678
	½	368	901	531	347	736	567
	1	319	812	376	481	748	653
	2	179	881	378	481	848	718
Alkanolamine salt	0	398	886	654	301	788	609
	⅛	299	938	352	418	758	636
	¼	361	981	500	383	839	588
	½	374	871	412	370	833	607
	1	290	943	375	483	831	614
	2	181	1023	334	438	766	717
L.S.D. (.05) =						N.S.	N.S.

*L.S.D. (.01) on per cent clover was 8.5%.

Table 3. The effect of 2,4–D applied August 15, 1950 on the yield and botanical composition of a Ladino clover-orchard grass pasture.

Formulation	Rate per acre	First cutting 1950 30 days after treatment*		Second cutting 1950 75 days after treatment		First cutting April 1951 240 days after treatment	
		Yield per acre		Yield per acre		Yield per acre	
		Clover	Grass	Clover	Grass	Clover	Grass
		lbs.		lbs.		lbs.	
Isopropyl ester	0	459	394	731	186	898	424
	⅛	272	341	577	168	746	409
	¼	373	425	828	193	994	395
	½	374	318	743	173	784	406
	1	175	499	452	261	646	641
	2	115	311	484	211	675	480
Alkanolamine salt	0	345	277	726	148	739	469
	⅛	439	383	772	183	726	508
	¼	228	342	519	177	894	361
	½	437	309	765	159	812	464
	1	339	256	762	169	795	348
	2	175	299	625	155	693	455
L.S.D. (.05) =						N.S.	N.S.

*L.S.D. (.01) on per cent clover was 8.5%.

Although Ladino clover yield was reduced as a result of treatment in April and October, the injury was apparently temporary with the possible exception of treatment with 2,4–D at high rates in October. Following treatment in October, Ladino clover had not fully recovered from the effects of ½ pound of 2,4–D per acre 180 days after treatment as shown in table 4. However, Ladino clover treated with as much as 2 pounds of 2,4–D per acre in April, June or August had recovered fully by April the following year.

It was observed in this study that a direct relationship seemed to exist between the overall degree of injury and the vigor and growth rate of Ladino clover at the time of treatment. The clover was grow-

Table 4. The effect of 2,4–D applied October 12, 1950 on the yield and botanical composition of a Ladino clover-orchard grass pasture.

Formulation	Rate per acre	First cutting 1950 30 days after treatment*		First cutting April 1951 180 days after treatment	
		Yield per acre		Yield per acre	
		Clover	Grass	Clover	Grass
		lbs.		lbs.	
Isopropyl ester	0	639	158	1075	380
	¼	623	254	972	499
	½	443	110	849	558
	¾	161	159	615	638
	1	10	128	606	591
	2	0	74	389	702
Alkanolamine salt	0	770	516	882	533
	¼	420	153	876	437
	½	185	197	781	563
	¾	88	188	691	813
	1	20	271	527	768
	2	0	94	223	603
L.S.D. (.05) =				271	N.S.

*L.S.D. (.01) on per cent clover was 8.5%.

ing vigorously and soil moisture was at a relatively high level when the chemicals were applied in April and October. Under these conditions, rapid downward movement of carbohydrates favoring downward movement of 2,4–D partially explains the susceptibility of Ladino clover to 2,4–D following treatment in April and October. Other research workers (7) have shown that downward movement of 2,4–D seemed to be associated with the downward translocation of carbohydrates. The growth rate and vigor of Ladino clover was relatively low when chemicals were applied in June and August. Under these conditions, Ladino clover was relatively tolerant to 2,4–D as shown by the yield data in tables 2 and 3.

The effect of 2,4–D on the rate of recovery of Ladino clover following different dates of application is presented in tables 1, 2, 3, and 4. The yield data from the spring cutting made in April 1951 following the April, June and August dates of application in 1950 indicate no significant differences in the yield of Ladino clover. However, significant yield reductions are still apparent in the April 1951 cutting following treatment in October 1950 as shown in table 4. Considerable winter-killing of the clover resulted from the application of 1 and 2 pounds of 2,4–D in the October treatment.

The effect of 2,4–D on the yield of orchard grass following different dates of application is shown in tables 1, 2, 3, and 4. The yield of orchard grass was not significantly affected by any rate of 2,4–D applied at any of the first three dates of application. Following the October 12 application, orchard grass was apparently slightly retarded in growth on plots receiving high rates of 2,4–D.

The effect of 2,4–D on the botanical composition of the pasture sward may be determined by examining the composition data in tables 1, 2, 3, and 4. The data indicate that the immediate effect of 2,4–D was to reduce the yield of Ladino clover causing an increase in the percentage of orchard grass in the mixture. The effect was

temporary as indicated by the composition data for the first cutting in 1951. Treatments made in April, June, and August 1950 apparently had no effect on the composition of the first cutting in 1951. The greatest changes in the botanical composition of the Ladino clover-orchard sward occurred following the October treatments as indicated in table 4. It may be seen that in April 1951 following treatments in October 1950, 2,4–D had greatly affected the composition of the sward. In general, as the rate of 2,4–D increased, the percentage of Ladino clover in the mixture decreased and the percentage of orchard grass increased. With but a few possible exceptions the increased percentage of orchard grass in the mixture was due to a decrease in the amount of Ladino clover rather than an increased yield of orchard grass. One exception may be noted in table 4. Data from the first cutting, April 1951, 180 days after treatment in October 1950, indicate a decreased yield of Ladino clover and an increased yield of orchard grass with increased rate of 2,4–D. The check plots contained approximately 70 percent Ladino clover and 30 percent orchard grass, while the plots receiving 2 pounds per acre of 2,4–D contained approximately 30 percent Ladino clover and 70 percent orchard grass (table 4).

There were no significant differences in the effects of an isopropyl ester formulation when compared to an alkanolamine salt formulation of 2,4–D on the yield and botanical composition of a Ladino clover orchard grass pasture sward following different dates and rates of application.

The effect of 2,4–D applied at different dates in 1950 on the yield of total forage in the first cutting in 1951 is presented in table 5. There were no marked differences in the yields of total forage due to formulation or rate of 2,4–D applied in April, June or August. The only severe reduction in yield in 1951 occurred as a result of the 2 pound rate of 2,4–D per acre, regardless of formulation, applied in October 1950. The data in table 5 indicate clearly that the ester or amine salt formulations of 2,4–D at rates sufficiently high enough to control most annual broadleaved weeds and many perennial weeds can be used safely in Ladino clover-orchard grass pastures if applied during tolerant stages of growth. Rainfall and temperature conditions prevailing 30 days before and after treatment are presented in Table 6.

The population of curled dock was not uniform enough to make a statistical analysis. However, stand counts and observations indicated that curled dock was much more susceptible to low rates of 2,4–D following treatment in October as compared to treatments made in June or August. Treatments made in April were intermediate with respect to the effect on curled dock.

SUMMARY

The possibility of using chemicals for weed control in a Ladino clover-orchard grass pasture was investigated in an effort to determine the stage of growth, rate of growth or season in which this grass-legume mixture was most tolerant to 2,4–D, to determine the

Table 5. The effect of 2,4–D applied at different dates and rates in 1950 on the yield of total forage in the first cutting in 1951.

Rate of 2,4-D per acre	Yields in pounds per acre of total forage harvested April 1951 after treatment on							
	April 10, 1950		June 15, 1950		August 15, 1950		October 12, 1950	
	Ester	Amine	Ester	Amine	Ester	Amine	Ester	Amine
lb.								
0	1453	1521	1315	1397	1322	1208	1455	1415
⅛	1640	1489	1351	1394	1155	1234	1471	1313
¼	1668	1478	1579	1427	1389	1255	1407	1344
½	1591	1559	1303	1439	1190	1276	1253	1504
1	1522	1427	1400	1445	1287	1143	1197	1295
2	1583	1468	1566	1483	1155	1148	1091	826

Table 6. Rainfall and temperature conditions prevailing 30 days before and after treatment.

Time and type of treatments	Total rainfall inches	Average daily maximum temperature °F
April 10, 1950		
30 days prior to treatment	2.34	63
30 days after treatment	2.59	77
June 15, 1950		
30 days prior to treatment	3.05	81
30 days after treatment	10.28	88
August 15, 1950		
30 days prior to treatment	1.45	88
30 days after treatment	4.41	87
October 12, 1950		
30 days prior to treatment	3.32	76
30 days after treatment	2.22	73

length of time required for recovery after treatment, to determine the most effective rate and formulation of 2,4–D to use on grass-legume pastures, and to study changes in botanical composition resulting from 2,4–D applications.

Six rates each of an isopropyl ester and an alkanolamine salt formulation of 2,4–D were applied in April, June, August and October 1950. The yield of Ladino clover, orchard grass, total forage, weeds, and the rate of recovery of the mixture after treatment were determined by making cuttings and subjecting the harvested samples to botanical analysis.

The principal results of this investigation may be summarized as follows:

1. Applications of an isopropyl ester or alkanolamine salt formulation of 2,4–D in April, June, and August, 1950 at rates ranging from 0 to 2 pounds acid equivalent per acre had no significant effects on the yield or botanical composition of a Ladino clover-orchard grass sward in April 1951.
2. Thirty days following treatment the growth and vigor of Ladino clover was still severely reduced where 2,4–D was applied at rates higher than ⅛ pound on April 15, 1 pound on June 15, ½ pound on August 15, and ¼ pound on October 12.

3. Ladino clover made good recovery in 75–90 days following application of ¼–½ pound of 2,4–D in April or October and following application of ½–1 pound in June or August.
4. A Ladino clover-orchard grass sward was much more susceptible to injury following treatments applied in April and October than those applied in June and August. Low rates of 2,4–D were generally less toxic to Ladino clover in October than in April.
5. An average of all rates and dates of application showed that there were no significant differences between formulations of an alkanolamine salt and an isopropyl ester of 2,4–D in their effect on the yield and botanical composition of a Ladino clover-orchard grass sward.

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Preliminary Studies in the Use of Herbicides for the Control of Weeds in Sansevieria[1]

EDWARD O. GANGSTAD, CHARLES C. SEALE and J. FRANK JOYNER[2]

A HIGH quality cordage fiber can be obtained from certain species of sansevieria (3, 5, 8, 10). Laboratory and small scale manufacturing tests indicate that this fiber is a suitable substitute for abaca, a fiber which is critical for defense purposes. (1, 9). Weed competition has been a major problem in the culture of sansevieria for fiber because the plant has a slow rate of growth and a long period of time is required to develop a stand.

Sansevieria is planted from either plants or leaf cuttings in rows 18 to 24 inches apart, spaced 6 to 12 inches in the row, and is allowed to develop a solid stand before harvesting the crop for fiber. Clean cultivation must be practiced for a period of 12 months or more to establish the stand. During this long period of cultivation, the plantings are almost certain to become infested with a persistent population of weeds. A wide variety of annual grass and broad leaf weeds are usually prevalent, but perennial weeds such as Bermuda grass, *Cynodon dactylon* Pers., and nut grass, *Cyperus rotundus* Pers., have been the most difficult to control.

Mechanical cultivation is not effective for control of weeds within the planted row, and cannot be practiced after the plants begin to fill between the rows. Mechanical methods are also impossible after harvest for a short period before the stand becomes reestablished. The high cost of hand weeding and the difficulty of mechanical methods make chemical control of weeds almost imperative for economic production of the crop.

The sansevieria plant has characteristics which indicate that control of weeds by application of selective herbicides is practicable (4). The results of preliminary studies on the effects of some commonly used herbicides on the sansevieria plant (6), and their possible use for weed control (7, 11) are summarized in this paper.

FOLIAGE APPLICATION OF HERBICIDES

Preliminary studies of the effects of some herbicides commonly used for control of weeds were made on a relatively uniform stand of *Sansevieria thyrsiflora* Thunb. (*S. guineensis* Willd.) growing on Leon fine sand near Boynton, Florida. The sansevieria was about 18 inches in height. Both broad leaf and grass weeds were present. The treatments were applied March 21, 1950 with a hand sprayer in 100 gallons of water per acre to 5 x 10 foot plots in two replicates in a random block design. Check plots received no treatment.

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The following herbicides were used at the rate generally recommended for weed control, and one-half and twice this rate:

1. Sodium trichloroacetate[3] (TCA sodium).
2. Aromatic oil fortified with pentachlorophenol[4] (PCP).
3. Dinitro ortho secondary amyl phenol[5] (DNOSAP).
4. Amine salt of 2,4–dichlorophenoxyacetic acid[6] (2,4–D amine).
5. Ammonium dinitro secondary butyl phenate[3] (DNOSBP).
6. Potassium cyanate[7] (KCNO).
7. Check

The effects of these treatments on *Sansevieria thyrsiflora* Thunb. (*S. guineensis* Willd.) are summarized in Table 1. Differences in total green weight were not significant six weeks after treatment and show a random pattern of distribution. The pounds of injured leaves per sub-plot sample and the percent of injured leaves to total yield

FIG. 1. Weed control of a field plot at Boynton, Florida, ten weeks after treatment (A) 4 and (B) 2 pounds per acre CMU. Note growth of weeds in 2 pound rate at this time.

indicate the effects of the treatments at this stage. Differences in the number of plants per square foot in the area sampled at six weeks gives a reasonable measure of the treatment effects six months after application of herbicides.

Five days after treatment, serious injury to the sansevieria was observed in plots treated with PCP and DNOSAP. Six weeks after treatment, serious injury was also observed in plots treated with TCA. Six months after treatment, all plots showed good recovery except those treated with TCA.

The results indicate that TCA is not satisfactory for control of weeds in sansevieria as a foliage spray, because the leaves are injured by contact of the chemical and the plants do not recover well after treatment. The rates of PCP and DNOSAP caused too much contact

[3, 4, 5, 6]Experimental quantities supplied by the Dow Chemical Company, Shell Oil Company, Standard Agricultural Chemicals, Inc., and Michigan Chemical Corp.

[3, 7]Experimental quantities supplied by the Dow Chemical Company and American Cyanamid Company, respectively.

injury to the sansevieria plant to be considered satisfactory for weed control.

The effective utilization of 2,4-D amine, DNOSBP ammonium salt and KCNO depends upon the specific weed problem. Pre-emergence or post-emergence application of 2,4-D will control most broad leaf species. Applications of DNOSBP ammonium salt and of KCNO will control many annual weeds. These chemicals, however, are not satisfactory for control of most perennial grass weeds.

Table 1. Summary of Effects of Some Commonly Used Herbicides on *Sansevieria thyrsiflora* Thunb. Growing on Leon Fine Sand at Boynton, Florida.

Herbicide	Rate of application active ingredient pounds per acre[1]	Six weeks after treatment			Six months after treatment	
		Per cent green wt. of check	Pounds injured leaves	Per cent average injury[2]	Plants per sq. ft.	Per cent number in check
TCA Sodium	22.5	99	6.4	28.5	4.0	27
	45.0	136	17.6	57.5	2.5	17
	90.0	116	20.2	77.5	2.5	17
Oil fortified with PCP[3]	4	108	8.6	35.5	15.0	100
	8	142	21.8	68.0	11.0	73
	12	118	16.1	60.5	13.0	87
DNOSAP	5.2	64	2.6	18.0	14.0	93
	10.4	77	5.3	30.5	12.5	83
	20.8	144	12.8	39.5	11.1	74
2,4-D Amine	0.5	133	3.3	11.0	13.0	86
	1.0	151	2.9	8.5	13.0	86
	2.0	110	1.5	6.0	9.0	60
DNOSBP Ammonium	1.1	64	1.3	9.0	11.0	73
	2.2	54	1.1	9.0	13.5	90
	4.4	124	0.7	2.5	10.0	67
KCNO	4.6	118	0.4	1.5	13.0	89
	9.1	89	0.4	2.0	13.0	89
	13.7	89	0.4	2.0	14.0	93

[1]Applied with hand sprayer in 100 gallons of water per acre.
[2]Per cent green weight of injured leaves to the total yield of plot.
[3]PCP in 5, 10 and 15 gallons of 16% aromatic oil emulsion.

PRE-PLANTING APPLICATION OF HERBICIDES

The most serious problem of weed control in sansevieria has been the control of perennial grass weeds. They become established in spite of careful cultivation and are very difficult to eradicate. Pre-planting treatments combined with mechanical cultivation, offer a possible solution to the problem. Preliminary studies were made on a weed infested area of Davie fine sand at Port Mayaca, Florida by application of herbicides shortly after mechanical cultivation of the experimental area.

The following treatments were applied by hand sprayer October 27, 1950:

1. Check (No treatment, not weeded)
2. Diethanolamine salt of maleic hydrazide[8] (MH)
3. Amine salt of 2,4–dichloroxpenoxyacetic acid[9] (2,4–D amine)
4. Polyethylene glycol derivative of 2,4–D[9] (2D3)

[8, 9, 10, 11]Experimental quantities supplied by U. S. Rubber Co., Michigan Chemical Corp., E. I. duPont de Nemours & Co., and the Dow Chemical Co., respectively.

5. Isopropyl ester of 2,4,5–trichlorophenoxyacetic acid[10] (2,4,5–*T* isopropyl ester)
6. Isopropyl ester of 2,4–dichlorophenoxyacetic acid[9] (2,4–D isopropyl ester)
7. Amine salt of 2,4–dichlorophenoxyacetic acid[9] (2,4–D amine) plus sodium trichloroacetate[11] (TCA sodium)
8. Sodium trichloroacetate[11] (TCA sodium)

One month after treatment, young plants of *S. trifasciata* Prain. were planted in the plots of all treatments in rows one foot apart and plants six inches apart in the row. Observations of the effects of the chemicals on the growth of the sansevieria and control of weeds six months after treatment are summarized in Table 2. No indications of serious injury to the sansevieria were observed and relatively good weed control was obtained in several treatments. Both grass and broad leaf weeds were controlled by TCA at the 30 pound rate

Table 2. Summary of the Effects of Herbicide Treatments on *Sansevieria trifasciata* Prain. and on Weeds per Square Foot, Six Months After Treatment, Port Mayaca, Florida.

Treatment	Rate of application active ingredient pounds per acre[1]	Sansevieria		Weeds	
		Dead plants	New rhizomes	Total number	Per cent of check
Check	0	0.0	0.6	10.7	100
MH	3	0.1	0.5	7.8	73
2,4-D amine	3	0.0	0.7	6.5	61
2D3	3	0.1	0.4	6.4	60
2,4,5-T Isopropyl ester	3	0.1	0.5	5.1	48
2,4-D Isopropyl ester	3	0.1	0.9	4.3	40
2,4-D amine + TCA Sodium	1.5[2] 15.0	0.1	0.5	4.0	37
TCA Sodium	30[2]	0.1	0.5	1.0	9

[1]Applied with hand sprayer in 60 gallons water.
[2]Applied in 225 gallons water.

for a period of approximately six months under the conditions of this experiment. However, the persistence of TCA in the soil varies considerably with weather conditions and low rates of TCA control but do not eliminate perennial grass weeds. This chemical has a limited value for control of weeds in sansevieria because it cannot be applied to a stand of sansevieria if perennial grasses become established after planting.

CONTROL OF PERENNIAL GRASS WEEDS WITH CMU

Preliminary trials indicated that 3–(p–chlorophenyl)–1, 1–dimethylurea (CMU) (2) was a very efficient herbicide for the control of perennial grass weeds. Experiments were laid out at five locations in small plots of four replicates each and in 2–4 field trials of 1/20 to 1/5 acre blocks to determine the concentration of CMU which would give effective weed control without injury to the sansevieria. The treatments were applied in May, June and July of 1951 with a small power sprayer in 100 gallons of water per acre. The observations and results of these experiments for a period of May through December, 1951 are summarized in Table 3.

On sandy soils, pre-emergence treatment with CMU at rates of 3

to 5 pounds active ingredient per acre gave good control of weeds for a period of five to six months. Post-emergence applications to relatively heavy growths of weeds at rates of 7 to 10 pounds active ingredient per acre gave good weed control for three to four months. The duration of the weed control was proportional to the rate of application, but varied with soil type, weed population and location.

The sansevieria was usually injured at rates above 10 pounds per acre, but most of the plants recovered in three to four months. High

Table 3. Summary of the Effects of CMU Treatments on the Control of Weeds and Injury of *Sansevieria trifasciata* Prain. in Experiments Carried Out from May Through December 1951 in South Florida.

Location and soil type	Rate of application active ingredient pounds per acre[1]	Weed control		Sansevieria injury
		Per cent[2]	Months[3]	
		Pre-emergence		
Boynton Light sand	2	90	2–3	Nil
	4	90	5–6	Nil
	6	90	6–7	Nil
		Post-emergence		
	4	72	5–6	Nil
	8	96	5–6	Nil
	12	98	5–6	Slight
		Pre-emergence		
Indiantown Light sand	4	75	3–4	Nil
	7	90	4–5	Nil
	10	100	5–6	Nil
	13	100	5–6	Slight
		Post-emergence		
	4	50	3–4	Nil
	8	60	4–5	Nil
	12	85	5–6	Slight
		Post-emergence		
Jupiter Light sand	10	55	1–2	Nil
	14	88	4–5	Nil
	18	83	5–6	Nil
Fort Lauderdale Mucky sand	10	70	3–4	Nil
	14	70	4–5	Slight
Belle Glade Peat	5	70	2–3	Nil
	10	70	3–4	Nil

[1]Treatment applied in 100 gal. water per acre.
[2]Per cent control on a green weight basis, as related to check, approximately one month after treatment.
[3]Months duration of satisfactory weed control as estimated from observations made each month, May–December 1951, or the point at which the active growth of a new population of weeds required further treatment.

rates of application were required on organic soils or under conditions of very high or very low rainfall.

In the course of these experiments it was observed that different populations of weeds developed as the season progressed.

Studies in progress indicate that certain broadleaf weeds not controlled by CMU can readily be killed with 2,4–D, DNOSBP ammonium salt or KCNO. Although combinations of CMU with low rates of TCA were very injurious to the sansevieria plant, combinations of CMU with moderate rates of 2,4–D gave satisfactory results.

SUMMARY AND CONCLUSIONS

Foliage sprays of TCA, PCP, and DNOSAP at the rates generally applied for weed control caused considerable injury to the sansevieria plant. Treatments with 2,4–D amine salt, DNOSBP ammonium salt and KCNO caused little injury to the sansevieria at rates suitable for control of broad leaf and annual grass weeds. Pre-planting treatments of TCA at 30 pounds per acre applied to a clean cultivated soil one month before planting, did not cause any apparent injury to the sansevieria and gave good control of weeds for a period of several months.

Pre-planting applications of TCA to control grass weeds and pre-emergence applications of other herbicides offer a satisfactory method of preventative weed control. However, this does not offer a means of weed control, should the perennial grasses become established in the sansevieria after planting. In such a case, preliminary trials indicate that CMU would be a very effective herbicide. On sandy soils pre-emergence treatment with CMU at 3 to 5 pounds per acre gave good control of perennial grasses for five to six months, while post-emergence application of 7 to 10 pounds per acre gave good results for three to four months. When more than 10 pounds CMU per acre was applied, the sansevieria was injured, but recovery took place in three to four months. CMU can be applied without injury to sansevieria in combination with 2,4–D, but not with TCA.

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The Influence of Soil Type on the Selective Action of Chloro–IPC and Sodium TCA[1]

ROGER BLOUCH and JESS FULTS[2]

CERTAIN members of the phenyl carbamate series and some salts of trichloroacetic acid have been known for several years to possess strong herbicidal properties, particularly toward monocotyledonous plants. This action has been described by Ivens and Blackman (4), McCall and Zahnley (5), Freed and Bierman (2), and others. Inconsistent results obtained in the usage of these chemicals have discouraged many workers from accepting them as useful weed control tools. Recently, Freed (3) analyzed several factors influencing the success or failure of IPC (isopropyl–n–phenyl carbamate). Among these are biochemical specificity, decomposition by soil microorganisms, moisture requirements, and stage of plant development. It has also been demonstrated by Anderson et al (1) that rapid evaporation of carbamates may be a critical factor at temperatures above 75°F.

Recently, it has been observed by the authors that the selective action of Chloro–IPC (o–isopropyl n–(3–chlorophenyl) carbamate) and Sodium TCA (sodium trichloracetate) is variable between soil types. In the same geographical and climatic areas, results have varied from satisfactory selectivity against grasses to complete non-selectivity at identical rates of application. It is the purpose of this paper to present certain preliminary laboratory and greenhouse data supporting these field observations.

METHODS AND MATERIALS

Three representative soils were chosen from the Greeley-Fort Collins area of northern Colorado. These were Valentine loamy fine sand, Fort Collins loam, and Terry silty clay loam. Samples of each were pulverized, screened, and placed in deep pine flats 13½ x 16 x 5½ inches. The following crops and grasses were then planted in these soils: sugar beets, onions, alfalfa and sweet clover, barley, crested wheatgrass, foxtail millet, and wild oats. Small-seeded species were planted ¼ inch deep; large-seeded species were planted ½ inch deep. Following planting, each flat received an irrigation sufficient to bring it to approximate field capacity. Herbicide applications were made 24 hours later, using a hand-operated Cornelius aerosol sprayer for uniform soil coverage. Chloro–IPC was applied at 3, 6, 9, and 12 pounds per acre, and Sodium TCA at 5, 10, and 15 pounds per acre. Throughout the test period each flat received a half-inch irrigation at 3-day intervals; this rate was found satisfactory for maintaining vigorous growth under greenhouse conditions. At 10-day intervals

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for 30 days, readings of growth inhibition were taken, as expressed by comparative heights measured in millimeters. Any further evidence of chemical activity was also recorded.

While these trials were being conducted, samples of each soil type used were analyzed by personnel of the Soil Conservation Service laboratory at Colorado A & M for pH, percentage organic matter and soluble salts, and parts per million of available phosphate, nitrate and potassium.

RESULTS AND DISCUSSION

Sodium TCA gave satisfactory selective action against grasses on Fort Collins loam at 5, 10 and 15 pounds per acre, acid equivalent. All grasses were inhibited strongly, whereas sugar beets, onions, and alfalfa yielded growth equal to the controls. On the Terry clay and Valentine sand, however, selectivity was apparent only at the 5-pound rate, and even then some crop injury was evident. On these soils sugar beets and alfalfa were almost as seriously suppressed as the

FIG. 1. Control flats in center foreground, showing little initial difference between grasses and crops growing on Valentine loamy fine sand (upper left), Fort Collins loam (middle), and Terry silty clay loam (lower right).

FIG. 2. Flats treated with Sodium TCA at 15 pounds per acre, acid equivalent. Selective weeding of annual grasses in center flat of Fort Collins loam, non-selective phytotoxicity on Valentine sand (upper left), and Terry clay loam (lower right). Note tolerance of onions.

grasses. Onion was the only crop exhibiting tolerance to TCA over all three soil types. Figure 1 (controls) and Figure 2 (TCA at 15 pounds) illustrate the influence of soil type on the selective action. Data from the 15-pound rate are shown in Figure 3.

Chloro–IPC treatment produced results similar to those described above for TCA. As illustrated in Table 1, rates as low as 3 pounds on Valentine sand and 6 pounds on Terry clay resulted in non-selective phytotoxicity, whereas considerable selectivity was shown on Fort Collins loam as high as 9 pounds per acre, active ingredient. Figure 1 (controls) and Figure 4 (C–IPC at 3, 6, 9, and 12 pounds) illustrate that results closely paralleled those obtained with Sodium TCA.

Analyses of the three soils yielded data which grouped Fort Collins loam into one category and Valentine loamy fine sand and Terry silty clay loam into another, as shown in Table 2. In contrast to the latter two, the loam contained high percentages of nitrate, phosphate, and total organic matter. Fort Collins loam contained 76 per-

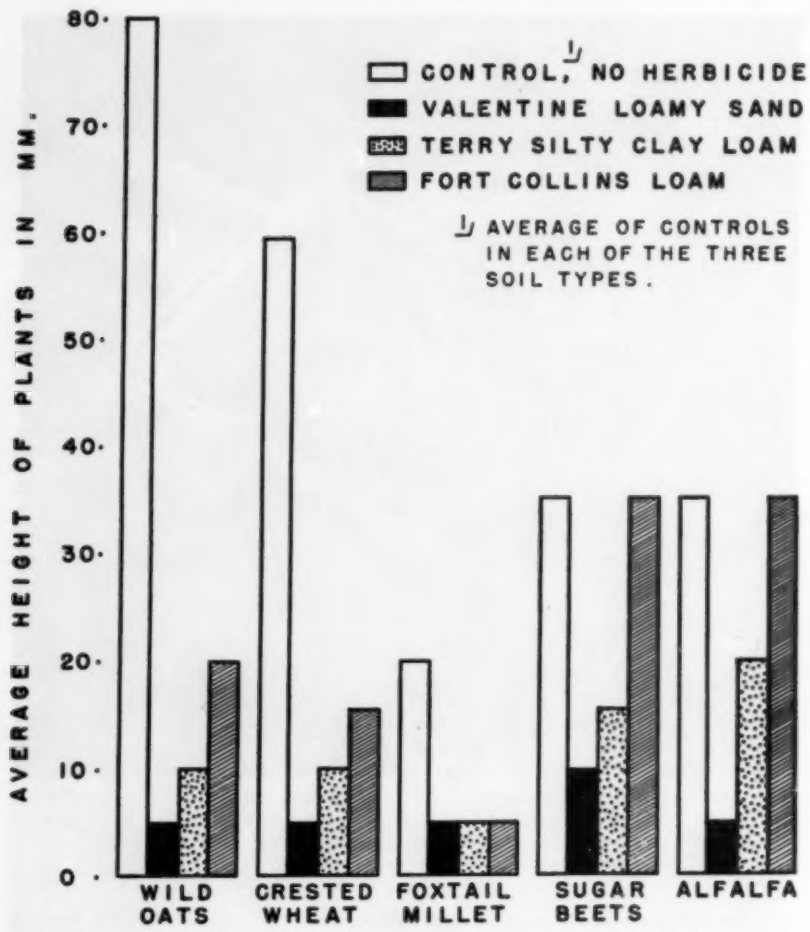

FIG. 3. The effect of soil type on the herbicidal action of Na–TCA. Pre-emergence application at 15 pounds per acre; measurements taken 20 days later.

cent more organic matter than Terry clay and 277 percent more than Valentine sand. There was nearly twice as much nitrate in the loam as in either the sand or clay, and the phosphate content was approximately eight and three times as much, respectively.

From the preliminary results obtained it appears that the selective effect of C–IPC and Sodium TCA on Fort Collins loam may possibly be due in part to adsorption of some of the herbicides by organic colloids, although other factors may also be involved.

SUMMARY

Selectivity of pre-emergence grass herbicides has varied between sites in the same geographical and climatic area of northern Colo-

Table 1. Effect of soil type on the selective herbicidal action of Chloro–IPC.

Plant spp.	Figures represent millimeters of height growth		
	Fort Collins loam	Valentine loamy fine sand	Terry silty clay loam
1) Foxtail millet control	20	20	20
3 lbs.	10	0	10
6 lbs.	10	0	5
9 lbs.	0	0	5
12 lbs.	0	0	0
2) Wild oats control	80	80	80
3 lbs.	20	10	15
6 lbs.	20	5	10
9 lbs.	10	0	10
12 lbs.	10	0	0
3) Malting barley control	200	150	200
3 lbs.	140	10	100
6 lbs.	100	0	15
9 lbs.	100	0	25
12 lbs.	30	0	15
4) Crested wheat control	60	60	60
3 lbs.	30	0	30
6 lbs.	20	0	20
9 lbs.	20	0	10
12 lbs.	0	0	0
5) Alfalfa and sweet clover control	35	35	25
3 lbs.	35	10	25
6 lbs.	35	5	15
9 lbs.	25	5	10
12 lbs.	15	0	5
6) Sugar beets control	35	30	30
3 lbs.	30	15	20
6 lbs.	30	0	10
9 lbs.	25	0	5
12 lbs.	15	0	0
7) Onions control	55	50	60
3 lbs.	55	50	50
6 lbs.	50	40	40
9 lbs.	45	25	40
12 lbs.	35	0	30

Table 2. Analyses of soil types used in studying the effects of organic matter and chemical composition on the selective action of Chloro–IPC and TCA as pre-emergence grass herbicides.[1]

Soil type	pH	Soluble salts	Organic matter	Lime	Phosphates	Nitrates	Potassium
		per cent	per cent	per cent	ppm.	ppm.	ppm.
Fort Collins loam	7.5	0.14	2.5	0.6	31.0	2.6	140
Valentine loamy fine sand	7.7	0.02	0.9	0.1	11.0	1.2	75
Terry silty clay loam	7.7	0.14	1.9	1.6	4.5	1.6	300

[1]Analyses by the Soil Conservation Service Soils Laboratory, Fort Collins, Colorado.

rado. In the thought that soil factors might be involved, preliminary laboratory and greenhouse experiments using three principal soil types of this area were employed. It was found that Chloro–IPC and Sodium TCA gave selective control of annual grasses without crop injury on Fort Collins loam, a medium-textured soil relatively high in organic matter, nitrate, and phosphate. Non-selective phytotoxicity resulted, however, when the same rates were applied to Valentine loamy fine sand and Terry silty clay loam. Both of these soils

FIG. 4. Flats treated with Chloro–IPC at 3, 6, 9, and 12 pounds per acre (reading from bottom to top). Crop tolerance to 9 pounds per acre on Fort Collins loam (center flats), none at any rate on Valentine sand (left), and only at 3 pounds on Terry clay loam (right). Note tolerance of Moravian malting barley.

were deficient in organic matter and total fertility. One possible explanation is that a substantial portion of the herbicide may be adsorbed by the organic colloids in the case of Fort Collins loam.

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Weed Populations as Related to Certain Cultivated Crops in the Connecticut River Valley, Mass.[1]

JONAS VENGRIS[2,3]

INTRODUCTION

WEEDS are plants that grow along with cultural plants, both groups making up a community. The prevalence of weed species becomes adjusted to cultural management practices and often, they are not able to survive without their cultivated counterpart. In this way, some weeds become more or less domesticated plants (e.g. *Bromus secalinus* L.).

The weed control problem, as old as agriculture itself, is one of the most expensive items in crop production. The recent introduction of hormone herbicides has created a new era in weed control. Since these herbicides are only tools, proper use of them must be based not only on a thorough knowledge of the weed population in a particular crop but also on the reaction of these weed species as well as the crop to the action of a given herbicide. A careful survey of the weed population in the various crops should be of great help to the research worker who is interested in control.

The primary objective of this research was to survey the weed population of the Connecticut River Valley area and to determine the relationship between weeds and each of the important cultivated crops grown there.

The Connecticut River Valley is a very intensive agricultural area, the main crops being tobacco, onions, potatoes, and corn. With few exceptions, the farmers do not use regular crop rotations, but they frequently raise the same crop on the same field year after year.

Under such a monoculture system, one would expect the weed population to be made up of a restricted number of highly specialized weed species well adapted to the soil fertility levels and crop management practices for each of the important crops grown. Thus, a study of the weed population in the various crops is of interest, not only from the practical standpoint of weed control but also from the purely ecological point of view as well.

LOCALITY

The area studied consisted of the terrace lands on both sides of the Connecticut River from Sunderland and South Deerfield on the north to the Holyoke Range and Northampton on the south. The area, which includes Franklin and Hampshire counties, is approxi-

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[3]The author wishes to express his appreciation to Professor Dr. William G. Colby, Head, Agronomy Department, and to Associate Professor Dr. R. B. Livingston, Botany Department, for their interest and suggestions in preparing the manuscript and to Professor Dr. R. E. Torrey for his assistance in identification of plants.

mately twelve miles long and five miles wide, and distinguishes itself as the most intensive farming area of the Connecticut River Valley. In size this area is relatively extensive and covers the larger part of the tobacco, onion, and potato area of the Connecticut River Valley in Massachusetts.

Connecticut River Valley soils belong to the Hadley and Agawam series. Hadley very fine sandy loam, the principal agricultural soil of the Valley and the most extensive in the area, is an alluvial soil. Agawam fine sandy loam, also alluvial, ranks next in agricultural importance.

The main crops are tobacco, onions, potatoes and corn. In general, the soils are productive but not fertile. Farmers do not attempt to grow tobacco, onions, or potatoes without using from one to two tons of complete fertilizers per acre. Tobacco yields 1500 to 2000 pounds per acre; onions, 500 to 1000 bushels; shelled corn, 50 to 100 bushels; potatoes 200 to 500; and corn for silage, 12 to 15 tons per acre.

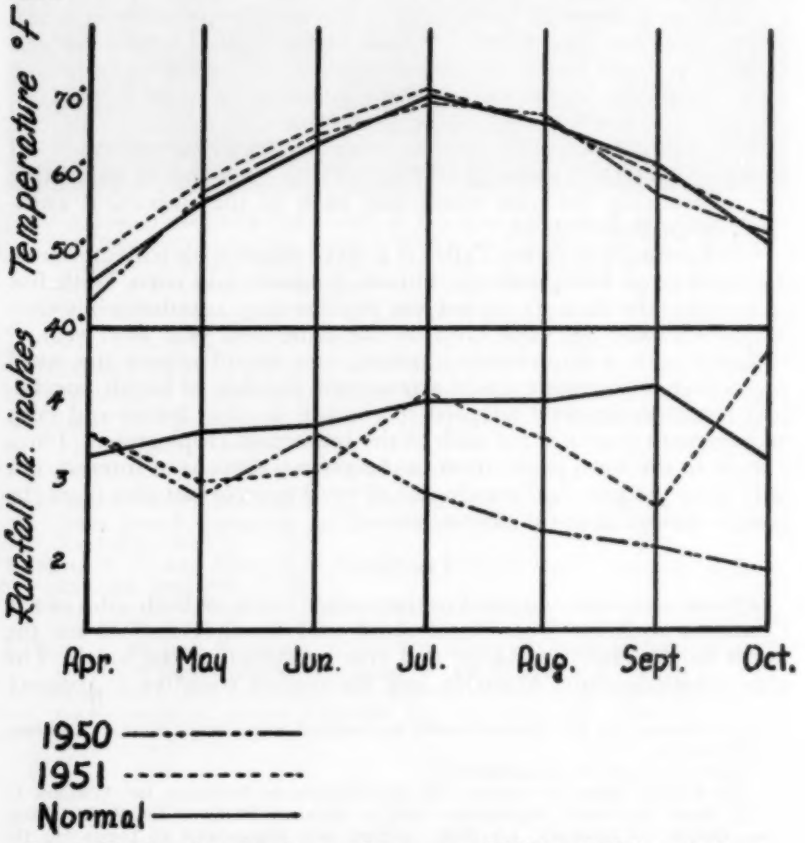

FIG. 1. Weather data for the growing season of 1950 and 1951 at Amherst, Massachusetts.

Climatological data for Amherst, Massachusetts, situated in the center of the surveyed area, are presented in Figure 1.

METHODS

A "quantitative" phytosociological weed survey was accomplished by the method used by Buchli (2), Knapp (7, 8), and Norris (10). This method is based on the Braun-Blanquet (1) estimation method. The *abundance-cover* estimate shows the number of individuals of each species in the stand. Values for each species were determined according to the following scale (2, 6, 10):

1. very rare, only single plants
2. rare but regularly scattered
3. infrequent, plants scattered everywhere, low covering space
4. abundant and covering a rather significant area
5. very abundant in number, mass, and space between cultural plants more or less filled up.

In the studies of these plant communities, in addition to relative abundance, relative presence is also important. The *presence* of a species is the percentage of investigated fields in which a species appears. Thus, if a species occurs in 30 of 60 investigated fields, it has a relative presence of 50 percent.

The survey itself was accomplished by traversing a field from one end to the other following a zig-zag path. Each species was listed as soon as it was observed. The abundance-cover ranking was checked and rechecked, and an ultimate grade was given when the survey of a given area was completed.

The fields were chosen at random and were evenly scattered throughout the survey area. The survey was made in 1950 and 1951 shortly before or at the harvesting time for each crop. For tobacco and corn, the date was about the first part of September; for potatoes, according to maturity in August and September; and for onions, the end of June and the beginning of July.

Pertinent data concerning the year, number of fields surveyed, average size of fields, and total acreage investigated are presented in Table 1.

Table 1. Crop, number of fields investigated, size of field, and total acreage investigated.

Crop	Number of fields investigated			Size of average field	Total acreage investigated
	1950	1951	Total		
				(acres)	(acres)
1. Tobacco, open grown	14	41	55	3.3	182
2. Tobacco, shade	11	13	24	5.8	139
3. Onions	8	21	29	2.9	82
4. Potatoes	11	35	46	5.7	262
5. Corn	12	36	48	3.2	156

Nomenclature for all but grasses is from "Gray's Manual of Botany" (3). Grasses are identified according to Hitchcock (4). The colloquial names were selected arbitrarily.

RESULTS AND DISCUSSION

Data on weed composition in the Connecticut Valley are presented in Tables 2, 3, 4, and 5. At first the data were tested separately for each year; however, since no differences were found to justify the discussion and presentation of data for 1950 and 1951 separately, the data were combined. Also, since open-grown and shade tobacco did not show any differences, the data for both types and both years were grouped into the same table.

Plant lists are presented according to the degree of presence; the species with the highest presence values are given first place, and those with the lowest values were given last place in the table.

To get a clearer picture of distribution patterns, the data have been grouped into five classes (2, 11): A, presence index of 1–20; B, 21–40; C, 41–60; D, 61–80; and E, 81–100. For purposes of comparison, the data are presented in diagram form in Figure 2. Essentially, the data follow Raunkiaer's Law (5, 11). Class A is normally very high because of the numerous sporadic species found with low presence in most stands. Class E and D species are frequent ones. Low values for B and C classes indicate that the stands are homogenous in spite of a high proportion of incidentals occurring sporadically. Weed presence diagrams agree closely with Raunkiaer's and Kenoyer's normals (11).

The data for different weeds follow a similar pattern with all cultivated crops. In general, only a few weed species have highest (E) and high (D) presence values. These weeds are common and therefore the most important. The low number of species in D and E

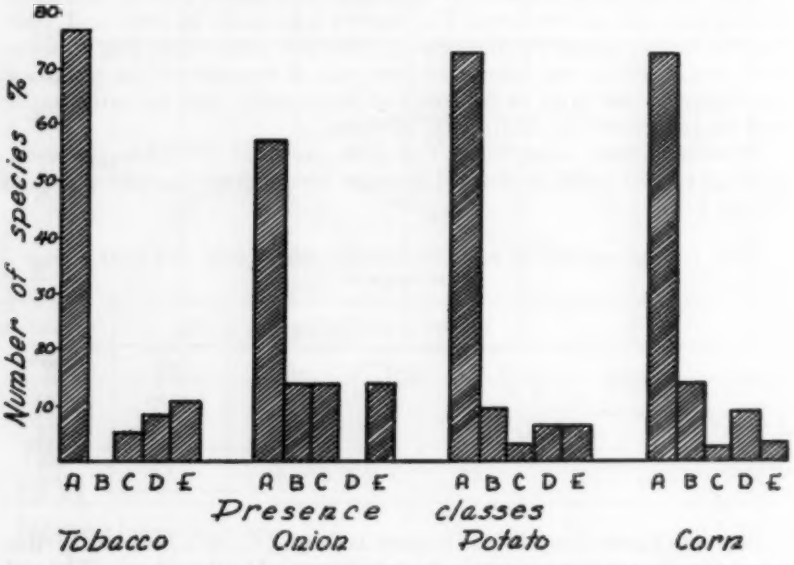

FIG. 2. Presence values for weed species in tobacco, onion, potato and corn fields in the Connecticut Valley of Massachusetts.

Table 2. Weed composition of tobacco fields showing degree of presence (P), abundance (A), and life form.†

Plant	P per cent	A mean	Life form†
1. *Digitaria sanguinalis*	95.0	2.6	a
2. *Echinochloa crusgalli*	91.2	1.8	a
3. *Chenopodium album*	91.2	1.8	a
4. *Portulaca oleracea*	82.3	1.9	a
5. *Amaranthus retroflexus*	77.2	1.3	a
6. *Panicum capillare*	69.6	1.3	a
7. *Mollugo verticillata*	69.6	2.1	a
8. *Stellaria media*	48.1	2.5	a, wa
9. *Amaranthus albus*	46.8	1.4	a
10. *Ambrosia artemisiifolia*	17.7	1.0	a
11. *Polygonum Persicaria*	17.7	1.1	a
12. *Polygonum pensylvanicum*	16.4	1.1	a
13. *Galinsoga parviflora*‡	12.7	1.8	a
14. *Lindernia dubia*	12.7	1.8	a
15. *Chenopodium paganum*	8.9	2.1	a
16. *Eleusine indica*	6.3	1.5	a
17. *Rumex Acetosella*	6.3	1.0	p
18. *Cyperus esculentus*	5.1	1.6	p
19. *Plantago major*	3.8	1.0	p
20. *Eragrostis cilianensis*	2.5	1.5	a
21. *Setaria lutescens*	2.5	1.0	a
22. *Capsella Bursa-pastoris*	2.5	1.5	a, wa
23. *Trifolium repens*	2.5	1.0	p
24. *Cyperus strigosus*	2.5	1.5	p
25. *Gnaphalium uliginosum*	2.5	1.5	a
26. *Rumex crispus*	2.5	1.0	p
27. *Chenopodium lanceolatum*	2.5	1.0	a
28. *Eragrostis pectinacea*	1.3	1.0	a
29. *Eragrostis multicaulis*	1.3	1.0	a
30. *Eragrostis pilosa*	1.3	1.0	a
31. *Chenopodium glaucum*	1.3	3.0	a
32. *Polygonum Hydropiper*	1.3	1.0	a
33. *Trifolium pratense*	1.3	1.0	p
34. *Vicia Cracca*	1.3	1.0	p
35. *Acalypha rhomboidea*	1.3	1.0	a
36. *Convolvulus arvensis*	1.3	1.0	p
37. *Brassica Kaber var. pinnatifida*	1.3	1.0	a
38. *Taraxacum officinale*	1.3	1.0	p
39. *Oxalis europaea*	1.3	1.0	p

†a = annual, wa = winter annual, ba = biennial, p = perennial.
‡According to Gray's manual 7th ed.

classes indicates that only few weeds are able to adjust themselves to the cultivated crop vegetation rhythms, intensive management practices, and environmental conditions. These weeds are stable companions of cultural plants.

Average abundance-cover values for each species together with life form (3, 9) are presented in the tables. Annual plants predominate. The perennial weeds constituted in tobacco, 28%; onions, 29%; potatoes, 29%; and corn, 42% of all weed species found. The rather high percentage of perennial weeds in cornfields is understandable as this crop is the least intensive crop in the Valley and is often grown as an intermediate crop when renovating deteriorated grassland sods to prepare seedbeds for new grass-legume mixtures. Common weeds of old grassland sods include *Rumex crispus* (yellow dock), *Onoclea sensibilis* (sensitive fern), *Plantago Rugelii* (pale plantain), *Plantago lanceolata* (ribgrass), *Cerastium vulgatum* (mouse-ear chickweed), and *Erigeron pulchellus* (robin's-plantain).

The number of weed species found with the different crops were as follows: onions, 34; tobacco, 39; potatoes, 55; and corn, 66. Norris (10) found 64 different species in Nebraska's cornfields.

Table 3. Weed composition of onion fields showing degree of presence (P), abundance (A), and life form.†

Plant	P per cent	A mean	Life form†
1. *Digitaria sanguinalis*	100.0	3.1	a
2. *Portulaca oleracea*	96.6	3.0	a
3. *Echinochloa crusgalli*	89.6	1.8	a
4. *Amaranthus retroflexus*	89.6	2.2	a
5. *Chenopodium album*	82.7	1.7	a
6. *Stellaria media*	58.6	2.6	a, wa
7. *Amaranthus albus*	58.6	1.9	a
8. *Panicum capillare*	51.7	1.8	a
9. *Mollugo verticillata*	51.7	2.8	a
10. *Polygonum pensylvanicum*	45.0	1.1	a
11. *Capsella Bursa-pastoris*	38.0	1.9	a, wa
12. *Agropyron repens*	31.0	1.2	p
13. *Setaria lutescens*	24.0	1.0	a
14. *Ambrosia artemisiifolia*	24.0	1.3	a
15. *Taraxacum officinale*	20.7	1.4	p
16. *Galinsoga parviflora*‡	13.8	1.5	a
17. *Polygonum Persicaria*	13.8	2.0	a
18. *Polygonum aviculare*	13.8	1.8	a
19. *Cyperus strigosus*	10.3	1.0	p
20. *Chenopodium glaucum*	10.3	1.7	a
21. *Plantago major*	10.3	1.0	p
22. *Poa annua*	6.9	1.5	a
23. *Gnaphalum uliginosum*	6.9	1.0	a
24. *Agrostis alba*	3.4	1.0	p
25. *Eragrostis virescens**	3.4	1.0	a
26. *Eragrostis pilosa*	3.4	1.0	a
27. *Chenopodium lanceolatum*	3.4	2.0	a
28. *Trifolium repens*	3.4	1.0	p
29. *Asclepias syriaca*	3.4	1.0	p
30. *Polygonum Convolvulus*	3.4	2.0	a
31. *Veronica peregrina*	3.4	2.0	a, wa
32. *Cyperus esculentis*	3.4	1.0	p
33. *Cirsium arvense*	3.4	1.0	p
34. *Muhlenbergia schreberi*	3.4	1.0	p

†a = annual, wa = winter annual, ba = biennial, p = perennial.
‡According to Gray's manual 7th ed.
*Found for the first time in Massachusetts.

In table 6 are data for all surveyed cropfield weeds with presence values greater than 40%, i.e., species of the three highest classes (C, D, E). These weeds are typical species of the Connecticut River Valley agricultural area.

Digitaria sanguinalis, Echinochloa crusgalli, Panicum capillare, Chenopodium album, Amaranthus retroflexus, and *Portulaca oleracea* are common, with presence over 40% with all four crops. *Stellaria media* with presence values about 50% is a rather prevalent weed in tobacco, onion, and potato fields. In cornfields, this weed is seldom found (presence, 21.0%). On the other hand, *Polygonum pensylvanicum,* rather common with corn (70.7%), potatoes (69.6%), and onions (45.0%), is very seldom found in tobacco fields (16.4%).

Polygonum Persicaria is well represented only in potato fields (65.2%); *Mollugo verticillata,* on the contrary, is seldom found with potatoes but is common with the other three crops.

Ambrosia artemisiifolia and *Amaranthus albus* occurring in the Connecticut River Valley indicates some sort of reciprocity; the first prevails in potato (50%) and cornfields (68.7%), but is seldom found with tobacco (17.7%) and onions (24.0%). *Amaranthus albus,* on the other hand, is seldom found in potatoes and corn but frequently in tobacco and onion fields. In *Amaranthus albus,* among other

Table 4. Weed composition of potato fields showing degree of presence (P), abundance (A), and life form.†

Plant	P per cent	A mean	Life form†
1. *Echinochloa crusgalli*	97.8	2.7	a
2. *Amaranthus retroflexus*	96.0	1.4	a
3. *Chenopodium album*	96.0	2.1	a
4. *Digitaria sanguinalis*	80.8	2.7	a
5. *Polygonum pensylvanicum*	69.6	2.1	a
6. *Panicum capillare*	69.6	1.5	a
7. *Polygonum Persicaria*	65.2	1.9	a
8. *Portulaca oleracea*	63.0	1.8	a
9. *Ambrosia artemisiifolia*	50.0	1.2	a
10. *Stellaria media*	45.6	2.3	a, wa
11. *Setaria lutescens*	39.2	1.4	a
12. *Chenopodium lanceolatum*	32.6	1.8	a
13. *Cyperus esculentus*	30.4	1.5	p
14. *Amaranthus albus*	21.7	1.4	a
15. *Asclepias syriaca*	21.7	1.2	p
16. *Mollugo verticillata*	19.5	1.9	a
17. *Convolvulus sepium*	10.8	2.0	p
18. *Equisetum arvense*	10.8	2.0	p
19. *Agropyron repens*	8.7	2.0	p
20. *Cyperus strigosus*	8.7	2.2	p
21. *Chenopodium paganum*	8.7	1.5	a
22. *Chenopodium glaucum*	8.7	1.5	a
23. *Galinsoga parviflora*	8.7	2.3	a
24. *Digitaria Ischaemum*	8.7	1.0	a
25. *Erigeron canadensis*	8.7	1.0	a
26. *Taraxacum officinale*	6.5	1.3	p
27. *Acalypha rhomboidea*	6.5	1.7	a
28. *Gnaphalum uliginosum*	6.5	1.3	a
29. *Polygonum Hydropiper*	6.5	1.0	a
30. *Polygonum lapathifolium*	4.4	2.3	a
31. *Polygonum Convolvulus*	4.4	1.5	a
32. *Oxalis europaea*	4.4	1.0	p
33. *Sisymbrium officinale*	4.4	1.0	a, wa
34. *Rumex crispus*	4.4	1.0	p
35. *Rorippa islandica*	4.4	1.0	a, wa
36. *Capsella Bursa-pastoris*	4.4	1.0	a, wa
37. *Rumex Acetosella*	4.4	1.0	p
38. *Trifolium repens*	4.4	1.0	p
39. *Plantago Rugelii*	2.2	1.0	p
40. *Oxalis spp.*	2.2	1.0	
41. *Bidens comosa*	2.2	1.0	a
42. *Lindernia dubia*	2.2	1.0	a
43. *Veronica peregrina*	2.2	1.0	a
44. *Raphanus Raphanistrum*	2.2	1.0	a, wa
45. *Solanum carolinense*	2.2	1.0	p
46. *Erigeron spp.*	2.2	1.0	
47. *Eragrostis pectinacea*	2.2	1.0	a
48. *Cerastium vulgatum*	2.2	1.0	p
49. *Hypericum mutilum var. parviflorum*	2.2	2.0	p
50. *Poa annua*	2.2	1.0	a
51. *Polygonum Careyi*	2.2	1.0	a
52. *Erigeron annuus*	2.2	1.0	a
53. *Solidago canadensis*	2.2	1.0	p
54. *Lepidium virginicum*	2.2	1.0	a, ba
55. *Bidens vulgata*	2.2	1.0	a

†a = annual, wa = winter annual, ba = biennial, p = perennial.

reasons, limited soil moisture might determine its presence. This weed usually appears on relatively dry, well drained soils.

Taking abundance-cover into consideration, we find that *Digitaria sanguinalis* is not only very common with all crops but also rather abundant, and so ranks as one of the most noxious weeds of the Valley. *Stellaria media* and *Mollugo verticillata* having a high degree of presence are also very abundant. Where these two weeds gain ascendancy, they usually cover the ground and fill up all the space between the cultural companion plants. Both, being small mat plants, are usually not able to compete with companion crops for light.

Table 5. Weed composition of corn fields showing degree of presence (P), abundance (A), and life form.†

Plant	P per cent	A mean	Life form†
1. *Digitaria sanguinalis*	85.4	2.9	a
2. *Chenopodium album*	85.4	2.3	a
3. *Amaranthus retroflexus*	73.0	1.7	a
4. *Polygonum pensylvanicum*	70.7	2.1	a
5. *Ambrosia artemisiifolia*	68.7	1.8	a
6. *Panicum capillare*	68.7	1.6	a
7. *Mollugo verticillata*	64.6	2.3	a
8. *Echinochloa crusgalli*	60.4	1.4	a
9. *Portulaca oleracea*	41.6	1.8	a
10. *Setaria lutescens*	39.6	2.1	a
11. *Asclepias syriaca*	27.1	1.1	p
12. *Agropyron repens*	23.0	2.1	p
13. *Cyperus esculentus*	23.0	1.6	p
14. *Amaranthus albus*	23.0	1.3	a
15. *Acalypha rhomboidea*	23.0	2.1	a
16. *Rumex Acetosella*	23.0	1.2	p
17. *Cyperus strigosus*	21.0	1.4	p
18. *Stellaria media*	21.0	2.3	a, wa
19. *Polygonum Persicaria*	18.8	1.2	a
20. *Taraxacum officinale*	14.6	1.7	p
21. *Galinsoga parviflora*	12.5	2.5	a
22. *Equisetum arvense*	12.5	2.1	p
23. *Oxalis europaea*	12.5	1.3	p
24. *Polygonum Hydropiper*	10.4	1.7	a
25. *Plantago major*	10.4	1.8	p
26. *Convolvulus sepium*	10.4	1.8	p
27. *Capsella Bursa-pastoris*	8.3	1.0	a, wa
28. *Gnaphalum uliginosum*	8.3	2.0	a
29. *Solanum carolinense*	8.3	2.0	p
30. *Erigeron canadensis*	8.3	1.0	a
31. *Chrysanthemum Leucanthemum*	6.3	1.0	p
32. *Potentilla norvegica*	6.3	1.0	a, ba
33. *Convolvulus arvensis*	6.3	2.3	p
34. *Rumex crispus*	6.3	1.0	p
35. *Onoclea sensibilis*	6.3	1.0	p
36. *Chenopodium lanceolatum*	4.2	1.0	a
37. *Polygonum Convolvulus*	4.2	1.0	a
38. *Plantago Rugelii*	4.2	1.0	p
39. *Lindernia dubia*	4.2	2.0	a
40. *Cerastium vulgatum*	4.2	1.0	p
41. *Eragrostis cilianensis*	4.2	1.5	a
42. *Hypericum mutilum var. parviflorum*	4.2	1.5	p
43. *Physalis subglabrata*	4.2	1.5	p
44. *Vicia Cracca*	4.2	1.5	p
45. *Euphorbia maculata*	4.2	1.0	a
46. *Muhlenbergia frondosa*	4.2	1.0	p
47. *Digitaria Ischaemum*	2.2	1.0	a
48. *Chenopodium paganum*	2.2	1.0	a
49. *Potentilla canadensis*	2.2	1.0	p
50. *Polygonum lapathifolium*	2.2	1.0	a
51. *Erigeron pulchellus*	2.2	2.0	p
52. *Plantago lanceolata*	2.2	1.0	p
53. *Barbarea vulgaris*	2.2	1.0	b, a, p
54. *Sonchus oleraceus*	2.2	1.0	a
55. *Trifolium repens*	2.2	1.0	p
56. *Trifolium pratense*	2.2	1.0	p
57. *Raphanus Raphanistrum*	2.2	1.0	a, wa
58. *Rorippa islandica*	2.2	2.0	a, ba
59. *Bidens comosa*	2.2	1.0	a
60. *Brassica Kaber var. pinnatifida*	2.2	2.0	a
61. *Hypericum spp.*	2.2	2.0	
62. *Sonchus arvensis*	2.2	1.0	p
63. *Lepidium virginicum*	2.2	2.0	a, ba
64. *Thlaspi arvense*	2.2	4.0	a
65. *Galeopsis Tetrahit*	2.2	1.0	a
66. *Juncus spp.*	2.2	1.0	

†a = annual, wa = winter annual, ba = biennial, p = perennial.

Sociability (1, 11) indicates how the individuals of a species are grouped or how they are distributed in a stand. In general, the most typical, frequent weeds were found uniformly scattered throughout the entire area. *Ambrosia artemisiifolia,* a common weed with corn

Table 6. Common weeds in the Connecticut River Valley, Massachusetts.

Species	Life form†	Tobacco‡		Onions		Potatoes		Corn	
		P	A	P	A	P	A	P	A
1. *Digitaria sanguinalis* Crabgrass	a	95.0	2.6	100.0	3.1	80.5	2.7	85.4	2.9
2. *Echinochloa crusgalli* Barnyard Grass	a	91.2	1.8	89.6	1.8	97.8	2.7	60.4	1.4
3. *Panicum capillare* Old-witch grass	a	69.6	1.3	51.7	1.6	69.6	1.5	68.7	1.6
4. *Chenopodium album* Lamb's-quarters	a	91.2	1.8	82.7	1.7	96.0	2.1	85.4	2.3
5. *Amaranthus retroflexus* Pigweed	a	77.2	1.3	89.6	2.2	96.0	1.4	73.0	1.7
6. *Portulaca oleracea* Purslane	a	82.3	1.9	96.6	3.0	63.0	1.8	41.6	1.8
7. *Stellaria media* Chickweed	a wa	48.1	2.5	58.6	2.6	45.6	2.3	21.0	2.3
8. *Polygonum pensylvanicum* Smartweed	a	16.4	1.1	45.0	1.1	69.6	2.1	70.7	2.1
9. *Polygonum Persicaria* Spotted smartweed	a	17.7	1.1	13.8	2.0	65.2	1.9	18.8	1.2
10. *Mollugo verticillata* Carpetweed	a	69.6	2.1	51.7	2.8	19.5	1.9	64.6	2.3
11. *Ambrosia artemisiifolia* Ragweed	a	17.7	1.0	24.0	1.3	50.0	1.2	68.7	1.8
12. *Amaranthus albus* White Pigweed	a	46.8	1.4	58.6	1.9	21.7	1.4	23.0	1.3

†a—annual; wa—winter annual.
‡P—Presence; A—Abundance-cover.

and potatoes, as a rule is more concentrated at the edges of the field. Usually this plant (12) is distributed throughout the entire field with a heavy growth of weed around the perimeter. *Stellaria media* and *Mollugo verticillata* often occur in smaller or larger colonies, i.e., not evenly dispersed throughout the entire area.

SUMMARY

In the scope of this phytosociological weed study a survey was made of the weed population of arable land in the Connecticut Valley, Massachusetts. Tobacco, onion, potato, and cornfield weeds were investigated in 1950 and 1951.

According to the presence values, the most common weeds found with different crops are listed as follows with highest values first and with the lowest last:

a. *Tobacco fields: Digitaria sanguinalis, Echinochloa crusgalli, Chenopodium album, Portulaca oleracea, Amaranthus retroflexus, Panicum capillare, Mollugo verticillata, Stellaria media,* and *Amaranthus albus.*

b. *Onion fields: Digitaria sanguinalis, Portulaca oleracea, Echinochloa crusgalli, Amaranthus retroflexus, Chenopodium album, Stellaria Media, Amaranthus albus, Panicum capillare, Mollugo verticillata,* and *Polygonum pensylvanicum.*

c. *Potato fields: Echinochloa crusgalli, Amaranthus retroflexus, Chenopodium album, Digitaria sanguinalis, Polygonum pensylvanicum, Panicum capillare, Polygonum Persicaria, Portulaca oleracea, Ambrosia artemisiifolia,* and *Stellaria media.*

d. *Cornfields: Digitaria sanguinalis, Chenopodium album, Amaranthus retroflexus, Polygonum pensylvanicum, Ambrosia artemisiifolia, Panicum capillare, Mollugo verticillata, Echinochloa crusgalli,* and *Portulaca oleracea.*

Weed flora of onion fields consisted of 34 species; tobacco, 39; potatoes, 55; and corn, 66.

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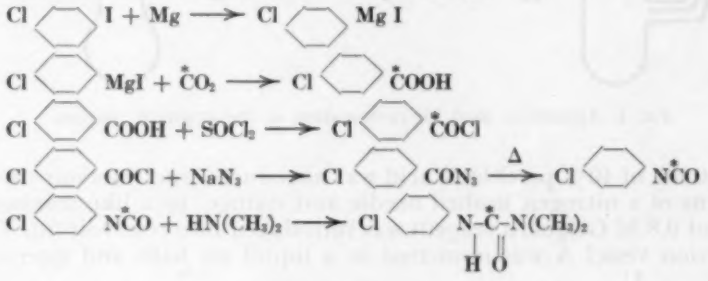
A Synthesis of C^{14} Carbonyl Labeled 3–(Parachlorophenyl)–1, 1–Dimethylurea[1]

ALBERT V. LOGAN and NORMAN R. ODELL[2]

THE synthesis of C^{14} carbonyl labeled 3–(parachlorophenyl)–1, 1–dimethylurea (CMU) was undertaken to provide a supply of the herbicide for use in studies of its mode of action and of its retention in the soil.

The coupling of dimethylamine and p–chlorophenyl–isocyanate to form CMU described by Bucha and Todd[3] appeared to offer the most direct approach for the radioactive synthesis. A method for the preparation of the radioactive p–chlorophenylisocyanate was developed similar to those described for closely related compounds by Barrett and Porter,[4] Naegali and Tyabji[5] and Schroeter.[6]

The overall synthesis involved the following five steps:



EXPERIMENTAL

0.51 g. (20.95 millimoles) of magnesium turnings were refluxed with 5.0 g. (20.95 millimoles) of p–chloroiodobenzene in 25 ml. of dry ether under a nitrogen atmosphere for 30 minutes. Yield of p–chlorophenylmagnesium iodide 95%.

The carbonation of the grignard reagent was effected in an apparatus (Fig. 1) similar to that reported by Van Bruggen.[7] 12.0 mg (0.060 millimoles) of $BaC^{14}O_3$ (specific activity 0.0818 mc./mg.) diluted with 185.4 mg. (0.939 millimoles) of inactive $BaCO_3$ were placed in flask B. Vial seals closed reservoirs (a) and (b). The apparatus was evacuated to about 12 mm. by connecting an aspirator to a #20 hypodermic needle inserted through vial seal into (a).

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[1]Published with the approval of the Committee on Publications, Oregon State College, as Research Paper No. 227, School of Science, Department of Chemistry.

[2]This article is based on a thesis submitted by Norman R. Odell, in partial fulfillment of the requirements for the degree of Master of Science at Oregon State College, June, 1952.

[3]H. C. Bucha and C. W. Porter, Science *114*, 493 (1951).

[4]E. W. Barrett and C. W. Porter, JACS *63*, 3434 (1941).

[5]C. Naegali and A. Tyabji, Helvetica Chimica Acta *16*, 349 (1933).

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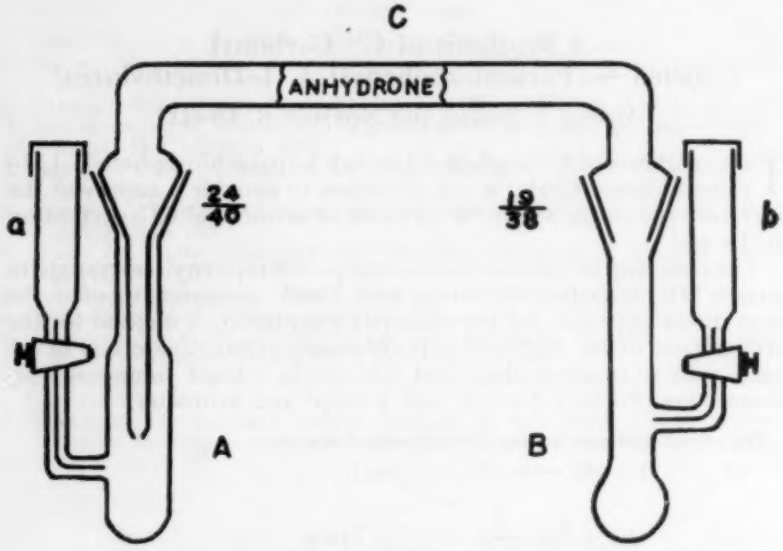

FIG. 1. Apparatus used for carbonation of the grignard reagent.

3.0 ml. of 40% perchloric acid was introduced into reservoir (b) by means of a nitrogen flushed needle and syringe. In a like manner 5 ml. of 0.8 M Grignard reagent was introduced into reservoir (a). The reaction vessel A was immersed in a liquid air bath and alternate layers of $^{*}CO_2$ and Grignard reagent were frozen out in A. After all of the $^{*}CO_2$ had been collected in A, the liquid air bath was replaced by an ice bath and the reaction between Grignard reagent and CO_2 was completed at 0°. The complex was decomposed with HCl. The p–chlorobenzoic acid was extracted first with ether and then with Na_2CO_3 solution. The acid was precipitated from the Na_2CO_3 solution, filtered and dried. Yield was 78.0% based on barium carbonate.

122.2 mg. (0.78 millimoles) of the radioactive p–chlorobenzoic acid in 2.0 ml. of dry toluene was refluxed for one hour with 7 ml. of thionyl chloride. Seven ml. of liquid was distilled off. Two successive addition of 5 ml. each of dry toluene were distilled off. To the 2 ml. of liquid remaining in the flask, 101.7 mg. (1.564 millimoles) of freshly activated[8] sodium azide was added. The mixture was refluxed for twenty-four hours. The flask was cooled in an ice bath and excess dimethylamine added. The mixture was warmed for ten minutes to remove any unreacted amine. The solution was filtered and the residue washed with 20 ml. of acetone. The solvent was evaporated. The residue was taken up in 1:4 HCl, the solution filtered, and the CMU precipitated by adding dilute NaOH. MP 171°.

[8]R. Adams et al (eds). Organic Reactions. New York, John Wiley and Sons, 1946 460 p.

The C^{14} labeled CMU was oxidized in a semimicro combustion apparatus using inactive CMU as a diluant and carrier. The $BaC^{14}O_3$ was deposited on one inch copper planchets and the samples were counted using a Tracerlab end-window counter (1.7 mg./cm.^{2} mica). The specific activity (corrected) for the C^{14} labeled CMU was 1.10 x 10^6 c/min./mg. The specific activity of the original $BaCO_3$ was 1.98 x 10^7c/min./mg. The radioactive yield was 53.6%; the chemical yield was 56.6% for the overall synthesis.

The Effects of Fresh Water Storage on the Germination of Certain Weed Seeds[1]

I. White Top, Russian Knapweed, Canada Thistle, Morning Glory, and Poverty Weed

V. F. Bruns and L. W. Rasmussen[2]

Water, especially water used for irrigation, has been adjudged for many years an important agent in the dissemination of weed seeds. Egginton and Robbins (7) found a total of 81 different species of weeds in 156 weed seed catches from three different ditches during 1918 and 1919 and determined that the number of weed seeds passing a given point on a ditch which averaged 12 feet in width during a period of 24 hours may reach several millions. Hope (11) analyzed a considerable number of weed seed catches from irrigation channels during 1924 and 1925. He computed that 1,674,030 seeds of 13 different weed species which occurred on the surface and to a depth of 1.57 inches in one 10-foot ditch passed during a 24-hour period on September 2, 1925. Further computations illustrated that the flow of weed seeds would amount to a deposition of 170,800 seeds per acre of land in one 6-inch irrigation. The latter computations were based on the assumption that the seeds were distributed uniformly over the cross section of the ditch at the point of catch.

The extent to which weed seeds are carried to farm lands by irrigation water depends, in part, on the degree of buoyancy of such seeds. Egginton and Robbins (7) secured data which showed that weed seeds differ in the readiness with which they sink or float. The buoyancy is influenced somewhat by the condition of the water surface and by the manner in which the seeds alight upon it. Some seeds float for days no matter how they strike the water surface or how it is agitated; some float if laid on the water carefully and the surface is not disturbed, but they sink readily if the surface is agitated, or sink almost immediately if they strike the surface with sufficient force. Bruns (4) dropped 100 seeds each of morning glory *(Convolvulus arvensis* L.), Russian knapweed *(Centaurea repens* L.), white top *(Cardaria draba* (L.), Desv. var. *repens* (Schrenk) O. E. Shulz), Canada thistle *(Cirsium arvense* L.), and poverty weed *(Iva axillaris* Pursh.) into separate 1 1/8-inch columns of still water 48 inches deep. Agitation to break the surface tension was supplied by vigorous stirring with a glass rod for short periods each day. This test indicated that the weed seeds were relatively buoyant and might be transported considerable distances by irrigation water.

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[1]Studies conducted at the Irrigation Experiment Station, Prosser, Washington. Published jointly by the U. S. Department of Agriculture and the Washington Agricultural Experiment Stations. Scientific Paper No. 1246, Washington Agric. Expt. Sta., Pullman. Project No. 951.

[2]Associate Agronomist, Division of Weed Investigations, BPISAE, U. S. Departmen of Agriculture, and Associate Professor, Agronomy Department, Washington State College, respectively.

How long can weed seeds remain in water and still be able to germinate and produce a plant? This question has been asked many times by those concerned with weed control in every irrigated region.

There are a number of records of longevity of weed seeds in dry storage and in undisturbed and cultivated soils (2, 3, 5, 6, 8, 9, 14). Under these conditions, seeds of many weeds retained viability for many years. Darlington's studies (6) showed that some seeds of *Rumex crispus, Oenothera biennis,* and *Verbascum Blattaria,* which were mixed with sand, enclosed in bottles, and buried in sandy soil approximately 18 inches below the surface of the ground, could be germinated after 70 years. The oldest historically dated seeds that have sprouted were 150 years old (3). It has been shown that many weed seeds could lie dormant in a farmer's field for 10 to 30 years, then sprout and flourish (2). There were few available records of the longevity of weed seeds in water storage, especially fresh water storage (1, 13).

This study was initiated in 1949 to determine (a) whether certain weed seeds would maintain viability when held in fresh running water and (b) whether these seeds after water storage for some time in reservoirs and canals would be capable of producing weed plants if they eventually reached farm lands.

METHODS AND MATERIALS

Seeds of white top (*Cardaria draba* (L.) Desv. var. *repens* (Schrenk) O. E. Shulz), Russian knapweed (*Centaurea repens* L.), Canada thistle (*Cirsium arvense* L.), morning glory (*Convolvulus arvensis* L.), and poverty weed (*Iva axillaris* Pursh.) were collected from fields in 1949. Nine thousand seeds of each species were divided into sample lots of 100 seeds and were placed in separate Lumite screen bags (36–mesh) which were sewed with nylon thread (Fig. 1). These bags retained the seeds while free circulation of the water was permitted. Five bags, each containing 100 seeds of a different weed species, were riveted together to provide composite samples for later germination studies. Nylon thread was used to tie the composite samples to eyebolts in ½-inch iron pipe standards (Fig. 2). Later, the composite samples were bolted directly to the standards as a safety measure.

FIG. 1. Lumite screen bags, sewed with nylon thread, were used to contain the noxious weed seeds in this experiment.

In order to hold the seed samples at both 12- and 48-inch depths in the water, standards were constructed from ½-inch iron pipe in the form of an inverted T-on-T (Fig. 3). Each pair of arms of a standard ini-

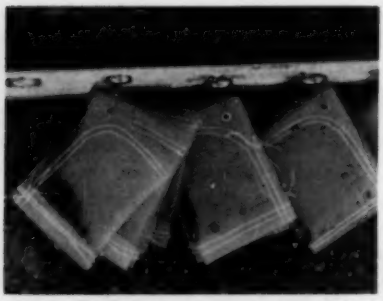

FIG. 2. Composite samples were tied securely by means of nylon thread to eye-bolts in the standards. Later, sample bags were bolted directly to the standards as a safety measure.

FIG. 3. Standards were constructed from ½-inch iron pipe. Each pair of arms of a standard initially held 15 composite seed samples.

tially held 15 composite seed samples. Three separate standards were used as replicates.

With permission from the Fish and Wildlife Service and the Bureau of Reclamation, each standard was attached to the hand-rail of the catwalk at the fish screens in the Prosser Power Canal, Prosser, Washington, on Sept. 14, 1949 (Fig. 4). The attach-

FIG. 4. Three standards were attached to the hand-rail of the catwalk at the fish screens in the Prosser Power canal. Special designed attachments permitted convenient raising and lowering of the standards.

ments were constructed in a manner to permit convenient raising and lowering of the standards for depth adjustments as well as for removal of samples for germination studies. The fish screens protected the standards from floating debris while the power-paddles served to aerate the water.

Composite samples from both the 12- and 48-inch depths were removed from each standard at various intervals over a 22-month period. Upon removal of composite samples, the seeds were taken from the bags, the number of seeds germinated and/or disintegrated were determined, and the seeds which appeared sound were placed in a germinator for a period of four weeks. Counts of germinating seeds in the germinator were made at six different intervals throughout the 4-week period. The temperatures in the germinator ranged from 68° to 72°F. No scarification of the seeds was employed.

The design of this experiment included seeds of five weed species, two depths of storage, three replicates, and 15 dates of germination tests and involved 45,000 seeds contained in 450 separate bags. In addition, surplus seeds from the original supply were held in dry storage for comparative germination tests. Temperature of the water in the canal was recorded frequently throughout the course of this experiment.

RESULTS AND DISCUSSION

With the exception of Russian knapweed, the weed seeds held in dry storage maintained a relatively uniform rate of germination throughout the 22-month period (Fig. 5). The germination of white

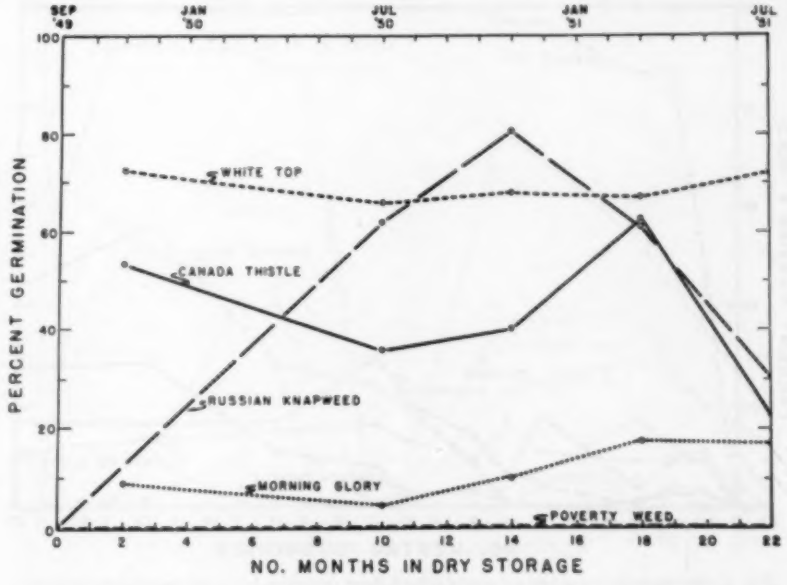

FIG. 5. Percentage germination of seeds which were held in dry storage for periods ranging from 0 to 22 months.

top seed ranged between 66.0 and 72.5 percent. The germination of Russian knapweed seed, after a low of 0.5 percent at the beginning of the experiment, reached a high of 80.7 percent after 14 months of dry storage and dropped to 30.7 percent after 22 months. The range in the germination of Canada thistle seed was between 23.0 and 62.7 percent, with the lowest percentage germination being recorded after 22 months of dry storage. The germination of morning glory seed was relatively low, ranging between 4.7 and 17.3 percent. No germination of poverty weed seed was obtained throughout the 22 months of dry storage. Several different methods of scarification were used during the initial stages of these tests in an attempt to break the dormancy of poverty weed seed, however, none of these methods was effective.

Some of the weed seeds, especially those of white top, actually sprouted while submersed in the water. When held in water, the percentage of white top seed which germinated and/or disintegrated increased quite rapidly (Fig. 6). The percentage averaged 51.8 and 87.8 after one month and two months of water storage, respectively. After six months of water storage, 98.0 percent or more of the white top seeds were no longer viable.

After six months, the percentages of Canada thistle and poverty weed seeds which had germinated and/or disintegrated in the water, although fluctuating, increased gradually. A mean of 27.5 and 44.5 percent of the Canada thistle and poverty weed seeds, respectively,

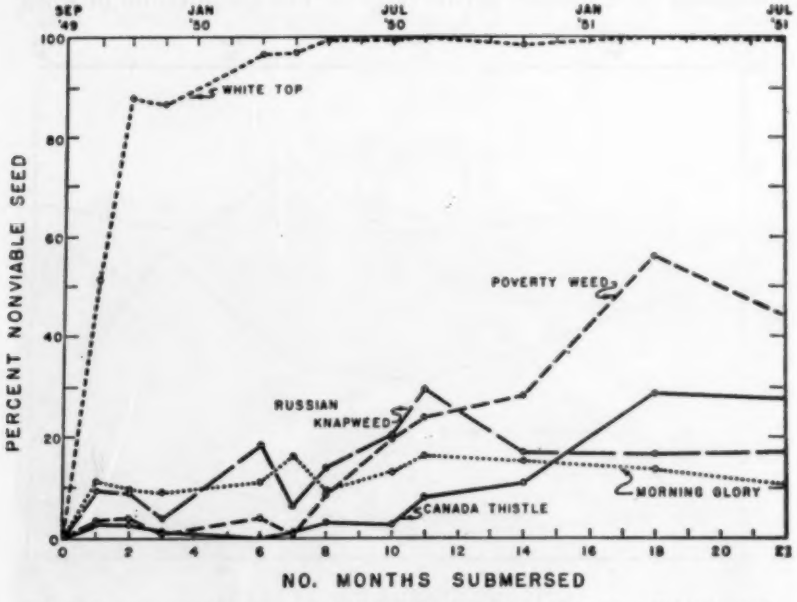

FIG. 6. Average percentage of seeds which had germinated and/or disintegrated during submergence in fresh water at 12- and 48-inch depths for periods ranging from 0 to 22 months.

were recorded as non-viable upon removal from the canal after 22 months of storage. More than 80 percent of the Russian knapweed and morning glory seeds appeared sound after 22 months in fresh water.

Upon removal of the composite samples from the canal for germination studies, only seeds which appeared sound were placed in the germinator. The data on total percentage germination, based on the initial number of seeds per sample and the number of seeds sprouting in the germinator, are presented in Fig. 7. The germination curves for Canada thistle, Russian knapweed, morning glory, and poverty weed, based on the number of seeds which actually were placed in the germinator, and the respective germination curves which are shown in Fig. 7 were similar. Apparently, the actual viability of these weed seeds was not affected greatly by the action of water during the 22-month storage period.

Total germination of white top seed dropped sharply from 72.5 percent to a mean of 11.8 percent after one month of storage in the canal. Mercer (12) reported that seeds of white top *(Lepidium draba)*

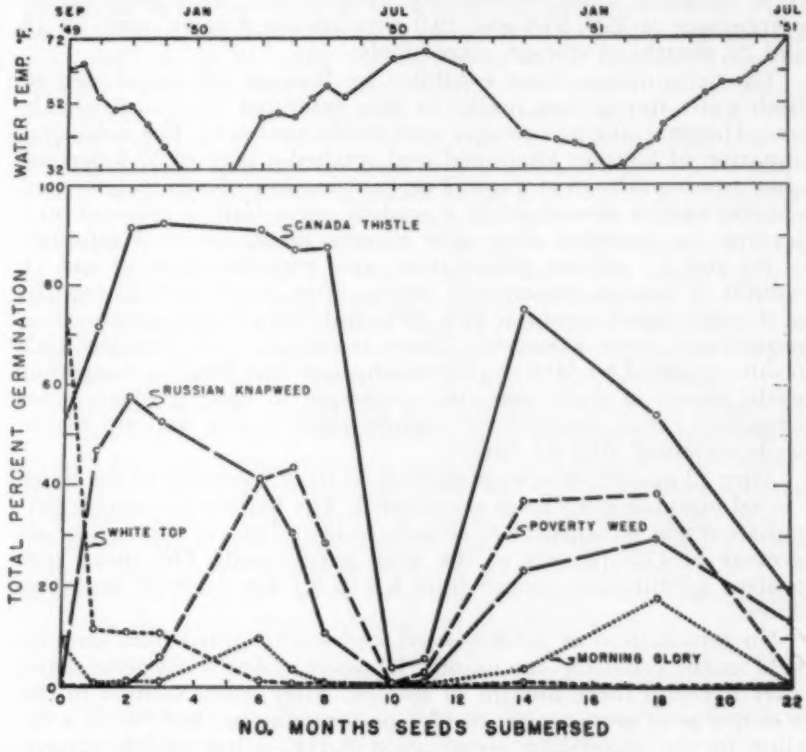

FIG. 7. Temperature of the water and the average total percentage of seeds which germinated after submergence at 12- and 48-inch depths for periods ranging from 0 to 22 months.

maintained 78 and 17 percent germination after being held for 117 and 174 days (approximately 4 and 6 months), respectively, in vials of water (changed every week to 10 days) which were kept in the laboratory at room temperatures and that none of the seeds sprouted while submerged. Another study showed that two out of 100 velvetleaf seeds, stored in a tightly corked bottle of water, remained sound and germinated after 20 years (1). Only an occasional white top seed (usually fewer than 2%) from samples held in the Prosser Power Canal germinated after six months of storage. Although inversely proportional, the germination curves of white top seed in Figs. 6 and 7 are in close agreement and indicate that water, under the conditions of this experiment, was a major factor in the destruction of the vitality of these seeds.

After two months of storage in water, the germination of Canada thistle seed had increased from a mean of 53.5 to 92.0 percent. Moreover, the mean germination ranged between 87.5 and 92.5 percent during the following three to eight months of storage. A sharp decrease in seed germination occurred after 10 and 11 months of storage, with 3.9 and 5.9 percent germination being recorded for these sampling dates, respectively. Surprisingly, high germination percentages of 75.0, 54.0 and 19.0 were obtained again after 14, 18 and 22 months of storage, respectively.

The germination curve exhibited by Russian knapweed seed in fresh water storage was similar to that exhibited by Canada thistle seed. However, the percentages were somewhat lower. The mean germination of Russian knapweed seed reached a high of 57.5 percent after two months of storage. The germination of subsequent seed samples ranged downward in a gradual curve until a mean of 10.3 percent was recorded after eight months in the water. Minimums of 0.4 and 1.1 percent germination were recorded after 10 and 11 months of storage, respectively. Again, after 14, 18, and 22 months of storage, higher means of 23.0, 29.5, and 13.5 percent germination, respectively, were obtained. These results do not coincide with results reported by Mercer (12) which show that Russian knapweed seeds, placed in cloth bags and submerged in flowing water in an irrigation canal, deteriorated rapidly under water and no viable seeds remained after 61 days.

After 22 months of storage in fresh water, 0.5 percent of the hard-coated morning glory seeds germinated. The highest percentage germination was recorded after 18 months of storage, at which time an average of 17.5 percent of the seeds germinated. The mean percentage germination ranged from 0.2 to 9.4 for all other sampling dates.

No germination of poverty weed seed was obtained from samples held in the canal for one month. However, a few seeds germinated after two and three months of storage. After seven months in the water, a peak germination of 43.2 percent was reached. With a decline in the succeeding germination curve, a low of 0.9 percent germination was recorded after 10 months of storage. Similar to the trends exhibited by Canada thistle and Russian knapweed seed,

means of 37.0, 38.0, and 3.3 percent germination were recorded for samples removed from the water after 14, 18, and 22 months of storage, respectively.

No consistent and significant differences in percentage germination of seeds held at different depths in the water were obtained, although there was a slight trend for lower percentages of germination of seeds taken from the 48-inch depth during the latter stages of the experiment. In comparison, Goss (8) buried seeds of 107 species of plants at depths of 8, 22, and 42 inches in the soil and found that the depth at which the seed was buried had little effect upon the preservation of their vitality.

The germination of Canada thistle, Russian knapweed, morning glory, and poverty weed seeds showed an inverse relationship to the temperature of the water in the canal. The germination was low when the water temperature was high and vice versa. The seeds of many types of plants differ in their responses to varying degrees of temperature, light and other factors. Warington (15) found that the germination of seeds of *Alopecurus, Alchemilla,* and *Papaver* was definitely inhibited when placed in arable soil and kept in a cellar or incubator where the daily fluctuations in temperature were slight and the light wholly or partially excluded. The inhibiting effect of the conditions in the cellar and incubator was attributed to the lack of sufficient fluctuation in temperature rather than to the reduction in light intensity, although with certain species this also may have played a part in the results. Harrington (10) reported that seeds of carrot, parsley, timothy, awnless brome grass, rye grasses, meadow fescue, and several kinds of flower seeds germinated practically as well at favorable constant temperatures (about 20°C.) as with an alternation of temperatures. Seeds of redtop and parsnip germinated better, and seeds of celery, orchard grass, Kentucky bluegrass, Bermuda grass, and Johnson grass germinated much better with favorable alternations of temperature than at constant temperatures. The exact alternation giving the best results depends upon the kind of seed and to some extent also upon its physiological condition.

Although further studies are needed, temperatures evidently influenced the fluctuation in germination of weed seeds under test at Prosser to a much greater degree than light and oxygen. The changes in water temperature, from high to low and vice versa, were seasonal and gradual. The seeds were subjected to the greatest change in temperatures when removed from the canal during the winter (low water temperature) and placed in the germinator (68–72°F.). Temperatures of the water in the canal during mid-summer were nearly equal to the temperatures maintained in the germinator.

SUMMARY

1. The effects of fresh water storage on the germination of seeds of five different species of noxious weeds were studied.
2. Seeds of white top (*Cardaria draba* (L.) Desv. var. *repens* (Shrenk) O. E. Shulz), Russian knapweed (*Centaurea repens* L.),

Canada thistle (*Cirsium arvense* L.), morning glory (*Convolvulus arvensis* L.), and poverty weed (*Iva axillaris* Pursh.) were placed in the Prosser Power Canal at 12- and 48-inch depths.

3. Samples of the submersed seeds were removed at various intervals over a 22-month period for germination studies.
4. There were no consistent differences in the percentage germination of seeds held at the 12-inch and 48-inch depths.
5. An inverse relationship was noted between the germination of Canada thistle, Russian knapweed, morning glory, and poverty weed seeds and the temperatures of the water in the canal.
6. The germination of Canada thistle seed after removal from the water increased from 53 to 92 percent during the first two months. The average germination of seed dropped below 6.0 percent after 10 and 11 months when water temperature was high. However, germination increased again as water temperature declined.
7. The germination of Russian knapweed seed increased from 0.5 to 57 percent after two months of fresh water storage and then fluctuated between 1 and 30 percent with the rise and fall in water temperature during the remainder of the storage period.
8. No germination of poverty weed seed occurred before two months of fresh water storage. The germination of the seed increased to a peak of 43 percent after seven months but dropped to less than 3.0 percent after 10 and 11 months. Germination again increased as water temperature declined.
9. The germination of morning glory seed fluctuated between 0.2 and 9 percent, except for a peak germination of 17 percent after 18 months of storage.
10. White top seed either germinated or disintegrated appreciably in fresh water storage and 98.0 percent or more of these seeds were no longer viable after six months.
11. It was evident that a relatively high percentage of the seeds of Canada thistle, Russian knapweed, morning glory, and poverty weed maintained sufficient viability after 22 months of fresh water storage to produce weed plants when placed under suitable conditions for germination.

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Effect of 2,4–D Sprays on the Growth of Young Sugar Cane[1]

JOHN R. HAVIS[2]

SUGAR cane appears to be suitable for the use of 2,4–D sprays for selective weed control. According to Young (1952) this is a regular commercial practice on some of the large plantations in Puerto Rico. The operators of certain plantations in Peru have found the application of 2,4–D to be economically practicable for broad-leaved weed control. Best and Gibbens (1951) have reported the value of 2,4–D sprays for sugar cane in Louisiana.

Concerning the use of 2,4–D in sugar cane, van Overbeek (1947) stated that " it would require special conditions, which rarely exist in agriculture, to kill, or even seriously damage a cane plant with 2,4–D". Nolla (1950), on the other hand, found that concentrations of 0.1 and 0.2 percent applied over the tops of the plants caused permanent bending, dwarfing and leaf discolorations. Plants less than three months old were more resistant than older plants, and plants under two months old could be sprayed "indiscriminately" with 2,4–D.

Pre-emergence applications of 2,4–D have been successful under conditions of relatively low rainfall and where the soil surface can be prepared free of clods and trash. In many regions, however, more effective weed control can be obtained from sprays applied after the weeds have emerged. This would mean in most instances that the sugar cane plants would be present also. The purpose of this investigation was to obtain information on the growth of the sugar cane plants following application of 2,4–D sprays to control the weed growth that normally appears about the same time as the young sugar cane.

METHODS

The experiments were conducted near Turrialba, Costa Rica, at an altitude of about 2,000 feet. The yearly precipitation of the area averages a little more than 100 inches. Monthly rainfall was 9 to 12 inches during the period that these experiments were conducted.

The experimental plots were laid out in fields of commercial sugar cane, varety POJ 2878. Nolla (1950) found this variety to be one of the most susceptible to injury from 2,4–D among the several varieties that he tested.

Randomized block designs and four replications were used. Each plot was about $^1/_{100}$ acre in size and consisted of four rows. For purposes of plant growth measurements, five or six representative plants in each of the two center rows were tagged and measured when the treatments were applied. The same plants were measured at successive weekly intervals for six or eight weeks following the treatments. The heights of the plants were measured from the ground to

[1]These studies were made possible by a grant from the Standard Oil Development Company, Linden, New Jersey.

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the highest visible dewlap, according to the system described by van Dillewijn (1952). The growth was calculated for the individual plants as the difference between two successive weeks' height measurements.

Sprays were applied with three-gallon knapsack sprayers equipped with "boom-jet"[3] nozzles.

RESULTS

Treatments in the first experiment were made one month after the sugar cane had been planted. The ground was well covered by weeds, which were two to four inches high. The sugar cane plants were about 15 inches in over-all height and had only one or two visible dewlaps. Figure 1 illustrates the size of the sugar cane one month after planting. The isopropyl ester of 2,4–D was applied at rates of one, two and four pounds acid equivalent per acre as a blanket spray over the tops of the sugar cane and weeds. The volume of spray was 30 gallons per acre.

The results from this experiment (figure 2) showed that the weekly growth rate was not affected by the one-pound rate. Two pounds per acre, however, caused a significant reduction in growth the second week after treatment and an increase the fourth week. Four pounds caused a reduction during the second and third weeks. Weed control was satisfactory in the plots sprayed with one pound and excellent in the plots treated with two and four pounds per acre.

FIG. 1. Size of sugar cane and weeds one month after planting.

[3]Manufactured by Spraying Systems Co., Chicago, Ill.

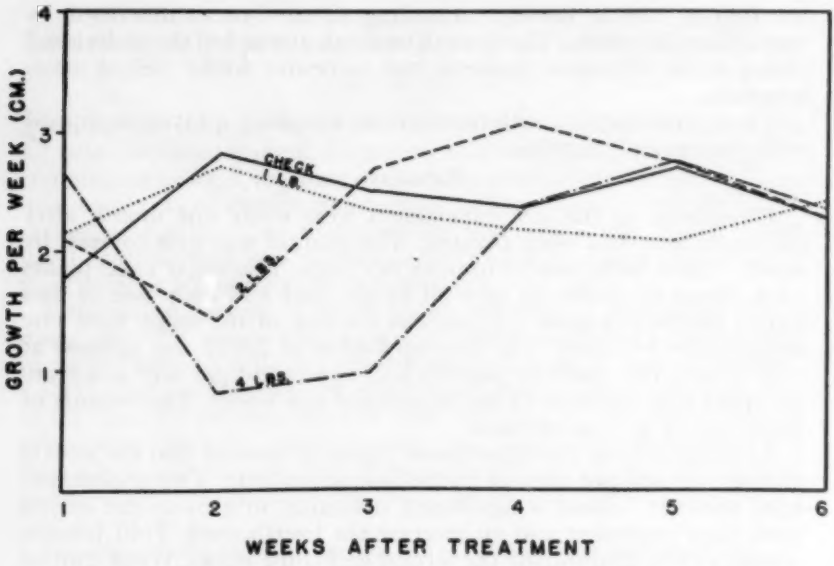

FIG. 2. Weekly growth rate of one-month-old sugar cane from 1, 2, and 4 pounds per acre of the isopropyl ester of 2,4–D applied over the tops of the plants (first experiment). Differences between the 2-pound rate and the check are significant the second and fourth weeks; between the 4-pound rate and the check the second and third weeks.

A second experiment was conducted on sugar cane that had been planted two months. The plants at this age were two feet high. Rates of one and one-third, two and four pounds per acre were applied in the same manner as in the first experiment. The weekly growth measurements, presented in figure 3, showed that none of the treatments had an adverse effect on growth during the six weeks following the applications. The weeds were considerably larger in this experiment than in the first one, but all of the rates gave satisfactory weed control.

A third experiment was conducted in this study, using one-month-old sugar cane. The purpose of this test was to compare the previously used formulation and method of application (isopropyl ester applied over the tops of the plants) with (a) the same method of applying the triethanolamine salt formulation and (b) the ester applied as a directed spray at the base of the plants. Rates used were two and four pounds of 2,4–D in 20 gallons of water per acre. Figure 4 illustrates the use of the "boom-jet" nozzles to obtain good weed coverage without spraying the tops of the small sugar cane plants.

The effects of the treatments in the third experiment are shown in figure 5. The ester formulation sprayed over the tops of the plants caused a marked reduction in growth. This check in growth occurred during the second and third weeks after treatment from the two-pound rate, and during the second through the sixth week from the

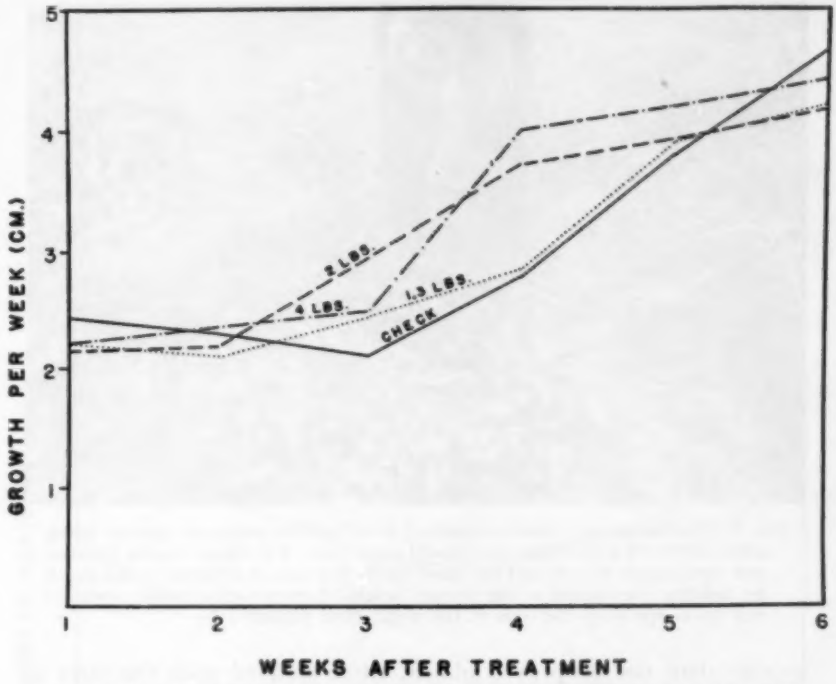

FIG. 3. Weekly growth rate of two-month-old sugar cane from 1.3, 2, and 4 pounds per acre of the isopropyl ester of 2,4–D applied over the tops of the plants. Differences are not significant.

four-pound rate. The triethanolamine formulation also caused a reduction in growth, although for only one week and two weeks from the two- and four-pound rates, respectively. The application of ester at the base of the plants caused a very slight reduction in growth the second week after treatment.

Table 1 shows the average heights of the plants in each treatment eight weeks after the sprays were applied. These data indicate the degree of recovery from the injury. The plants that had been sprayed with four pounds per acre of the isopropyl ester were 18.6 percent

Table 1. Average heights of sugar cane plants eight weeks after application of 2,4–D sprays. Plants were one month old at the time of treatment.

Formulation and rate of 2,4-D	Method of application	Height of plants (cm.)
Not sprayed		29.8
Isopropyl ester 2 lbs./A.	Over tops	26.6*
Isopropyl ester 4 lbs./A.	Over tops	24.2†
Isopropyl ester 2 lbs./A.	Base of plants	30.5
Isopropyl ester 4 lbs./A.	Base of plants	29.5
Triethanolamine 2 lbs./A.	Over tops	28.7
Triethanolamine 4 lbs./A.	Over tops	26.1*

*Significantly different from check at 5% level.
†Significantly different from check at 1% level.

FIG. 4. The "boom-jet" nozzles attached to a 3-gallon knapsack sprayer being used to spray 2,4–D in one-month-old sugar cane. The entire width between two rows (about 6 feet) and the rows themselves can be covered in one swath by holding the nozzles at the proper height. A reasonably careful operator can avoid spraying the tops of the sugar cane plants.

shorter than the unsprayed plants; those sprayed with the ester at two pounds per acre were 10.8 percent shorter; and those sprayed with the triethanolamine salt at four pounds per acre were 12.5 percent shorter than the unsprayed plants. The plants in the other treatments were not significantly different in size from the untreated. These height data, as well as the weekly growth data in figure 5, indicate that somewhat less injury was produced by the triethanolamine salt than the isopropyl ester when applications were made over the tops of the plants. The safest treatments, however, were those at the base of the plants.

DISCUSSION

These experiments, as well as unpublished results from several other tests of 2,4–D sprays in sugar cane, have indicated that there is no necessity for exceeding two pounds per acre for the control of many broad-leaved weeds. One pound or one and one-half pounds per acre were often adequate when the weeds were relatively small. These rates may be applied accurately with tractor-mounted spray equipment where the size of the field and the terrain allow the use of such equipment. In some sugar cane areas, however, particularly in Central America, hand operated sprayers are the only practical means of applying herbicides. Considerable variation in rate of application occurs with hand application. Some parts of the field receive less, and some parts more than the desired number of pounds per acre due to inaccuracies of the operators. The results of the

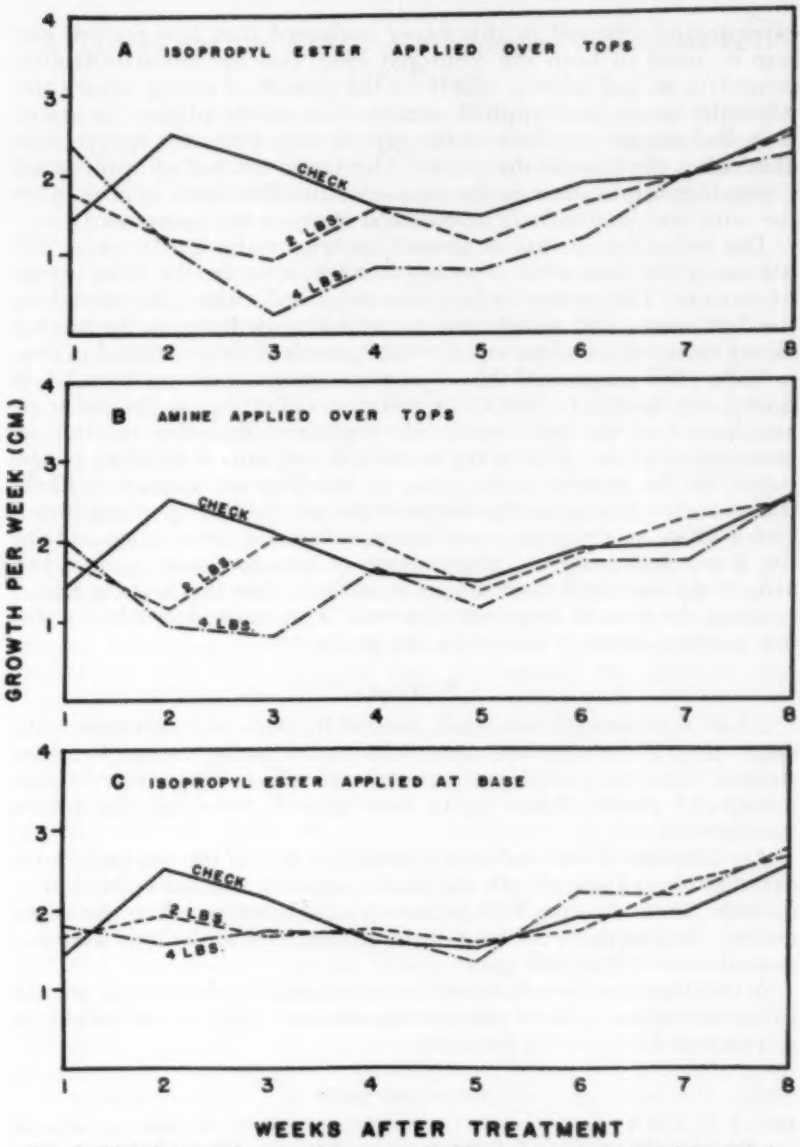

FIG. 5. Weekly growth rate of one-month-old sugar cane from 2,4–D (third experiment). *A*. Response from 2 and 4 pounds per acre of isopropyl ester sprayed over the tops. Differences between the 2-pound rate and the check are significant the second and third weeks; between the 4-pound rate and the check from the second through the sixth week. *B*. Response from 2 and 4 pounds per acre of triethanolamine salt sprayed over the tops. Differences between the 2-pound rate and the check are significant the second week; between the 4-pound rate and the check the second and third weeks. *C*. Response from 2 and 4 pounds per acre of the isopropyl ester sprayed at the base of the plants. Differences between the 4-pound rate and the check are significant the second week.

experiments reported in this paper indicated that two pounds per acre or more of both the isopropyl ester and the triethanolamine formulations had adverse effects on the growth of young sugar cane when the sprays were applied over the tops of the plants. The same rates had almost no effect on the growth rate when the sprays were directed at the base of the plants. The latter method of application – avoiding application to the tops – would, therefore, appear to be the safer one, particularly when hand sprayers are being used.

The reduction in rate of growth caused by the 2,4–D sprays did not occur the first week after application, even in the most severe treatments. The greatest effect was exhibited either the second or the third week, after which time the weekly growth rate of the treated plants eventually became equal to the growth of the untreated plants.

Nolla (1950) suggested that injury to sugar cane plants from 2,4–D sprays was caused by the spray solution collecting at the point of attachment of the leaf sheath. He explained that this resulted in penetration of the intercalary meristems and caused bending of the culms. In the present study, since no bending occurred, it is likely that entrance was down the throat of the plant to the growing point, rather than at intercalary meristems. Necrotic areas appeared on the leaves following the applications of two and four pounds per acre of the isopropyl ester, but it is unlikely that this was the direct cause of the growth responses observed. The amine formulation did not produce necrotic injury to the leaves.

SUMMARY

2,4–D was sprayed for weed control in one- and two-month-old sugar cane. Weekly growth measurements following the applications showed that one pound per acre did not affect the growth of one-month-old plants. Rates up to four pounds were safe for plants two months old.

Applications of two and four pounds per acre of the isopropyl ester over the tops of one-month-old plants caused a marked reduction in growth. The same rates were relatively safe, however, when the applications were made at the base of the plants, so that the tops were not actually covered by the spray.

A triethanolamine salt formulation caused a reduction in growth of one-month-old plants when the sprays were applied over the tops at two and four pounds per acre.

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Comments:

A Theory for the Selective Mechanism of Chloro IPC[1]

S. K. Ries[2]

The purpose of these comments is to introduce a new approach to an understanding of the possible mechanism for the selective herbicidal action of Isopropyl N–(3–chlorophenyl) Carbamate (CIPC). The theory which follows has developed from field experiments and from more than 75 laboratory experiments.

Templeman and Sexton (1945) first reported on the use of IPC as an herbicide. Ennis (1948), Ivens (1949) and Doxey (1949) competently described the toxic mechanism of the phenyl carbamates. In general, they agreed that these chemicals cause a decrease in the rate of cell division in contrast to 2,4–D which causes an increase in cell division. They observed an increase in the chromosome number of the affected plants; also an increase in the number of metaphase figures and a decrease in the number of anaphase and telophase figures. This interruption of normal cell division was accompanied by a tremendous increase in the size of existing cells.

No plant studied to date is completely resistant to the phenyl carbamates, but at certain concentrations one species may be killed while another may survive. It is on this basis that selectivity is obtained with CIPC. A typical example of this phenomenon is that under laboratory conditions less than 0.5 ppm of CIPC causes significant inhibition of root elongation in A & C cucumber *(Cucumis sativa)* but more than 10 ppm does not inhibit the primary root elongation in Early Prolific Straightneck squash *(Cucurbita pepo)*.

To date there has been relatively little speculation in print as to the nature of this selectivity, and practically no direct experimental evidence on the subject. However, many workers have studied phenyl carbamates in the field and laboratory from the standpoint of plant response. There is available, consequently, ample evidence as to which species are "susceptible" and which are "tolerant."

This investigation was predicated on the belief that factors responsible for the selective mechanism of CIPC could be determined best by studying the responses of representative types of both "resistant" and "susceptible" species, rather than studying only one type.

Data from experiments involving the effects of seed extracts, seed leachates, and seedling growth on the herbicidal action of CIPC furnished evidence for the following theory: It is proposed that the selective mechanism of species resistant to CIPC is due to a substance or substances produced by these species which in some way depresses the activity of the herbicide within as well as outside the plant or seed. It is suggested that in "resistant" species the rate of production

[1]Paper No. 369 of the Department of Vegetable Crops, N. Y. S. College of Agriculture, Ithaca, N. Y. Part of this work was made possible by grants from the Standard Oil Development Company and from Columbia-Southern Chemical Company. A detailed report of methods and experimental results will appear in September 1953 as a Cornell Ph.D. thesis. The author wishes to acknowledge the assistance of Professors R. Brown, D. G. Clark, W. C. Kelly, and R. D. Sweet.

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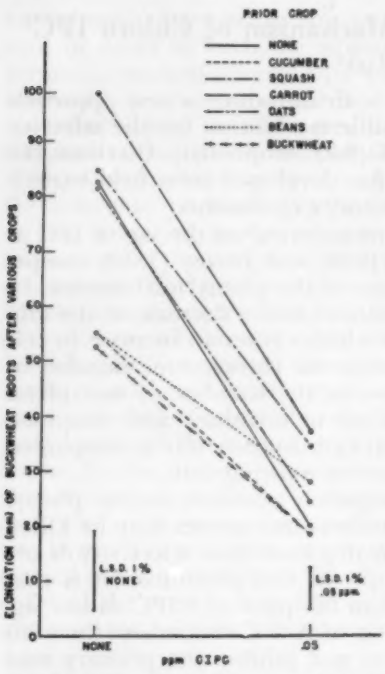

FIG. 1. Root elongation of buckwheat as a measure of "depression" of CIPC herbicidal activity. Data are means of 3 replications, 10 seeds each. Note that all three "resistant" crops: carrot, squash and bean, depressed CIPC activity as compared to no crop; in spite of the effect of the previous crop on the no CIPC buckwheat check.

of these "antidoting" substance(s) is higher than in "susceptible" species. Toxicity is established when the rate of production of these substances falls below a certain critical level, which varies with each plant species.

A typical experiment is described which illustrates the basis for the theory as well as some of the difficulties in technique encountered when one works with seed extracts, leachates, etc. A bio-assay was developed in which the amount of root elongation of seedlings was used to evaluate CIPC activity. Several species were screened for the bioassay. Buckwheat *(Fagopyrum esculentum)* or *(F. sagittatum)* was chosen because it is extremely susceptible to injury by CIPC, and because it germinates and grows rapidly. Also, root elongation measurements are easily made. Buckwheat under laboratory conditions produced at 30° C. a root length of 80 to 90 mm in three days starting from seed. After emerging from the seed coat, root extension averaged about 2 mm per hour. Root extension was significantly inhibited by concentrations of CIPC as low as .02 ppm. A dosage curve for rates from 0 to 0.1 ppm was sigmoid.

Seed of carrot (Red Cored Chantenay), oats (Mohawk), and snap beans (Stringless Black Valentine) were pre-germinated for three days at 30° C. in standard seed germination paper "rag-dolls." Six replicate dishes of seedlings (50 carrot, 15 oats, 7 beans per each) were placed in petri dishes containing two filter papers. In additional dishes were placed seeds not pregerminated as follows: 15 Early Summer Crookneck squash, 15 A & C cucumber, and 25 of Japanese buckwheat. Also one series of petri dishes was setup in which no seeds or seedlings were grown. Six c.c. of distilled water were added to all the dishes including those with no seeds. They were then placed in a dark chamber controlled at 30° C. After four days all seedlings were taken from the dishes. To three dishes of each crop series and to three which had not contained seeds was then added one c.c. of a 0.25 ppm solution of CIPC. To each of these same dishes as well as

to all those in the three replicates not receiving CIPC was added sufficient distilled water to bring the total liquid volume up to approximately 5 c.c. Ten seeds of buckwheat were then placed in each dish. The dishes were returned to the 30° dark chamber for three days.

After the three-day germination period the root elongation for each germinated seed was recorded. The mean length of roots in each dish was used for the analysis of variance. The averages for each treatment are presented in figure 1. One of the most striking observations was that the prior growth of all three "resistant" crops (carrot, squash, and bean) caused apparent inactivation of CIPC as compared with the check. None of the "susceptible" crops (oat, cucumber, and buckwheat) had this effect. It should be emphasized that this response occurred in spite of the tendency for certain crops (beans in this experiment) to depress root elongation of buckwheat when no CIPC was present.

The data in figure 1 are typical of the decreased activity of CIPC when exposed to "resistant" as compared to "susceptible" species under the following conditions:

1. When plants are grown in the presence of CIPC.
2. When seeds are soaked in solutions of CIPC.
3. When seeds or seed parts are leached with water and the CIPC added later.

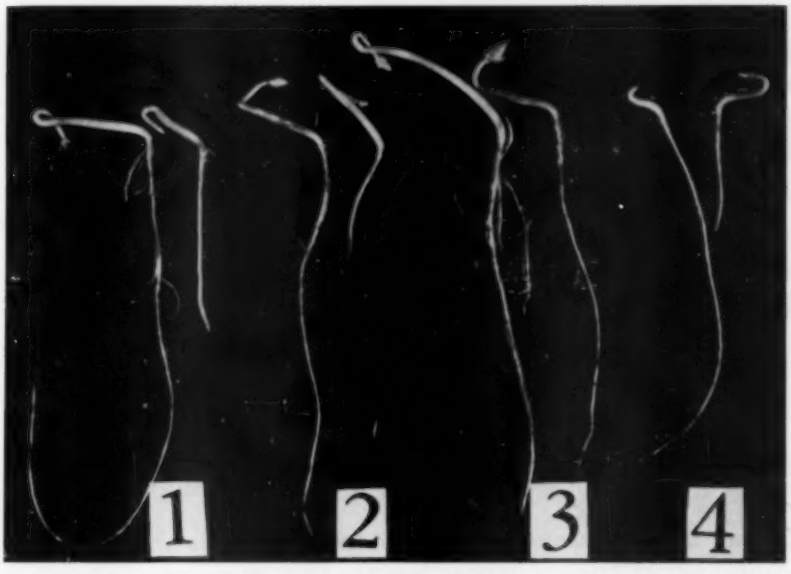

FIG. 2. Typical "depression" of CIPC herbicidal activity by a "resistant" plant. These roots represent mean lengths of buckwheat roots. The seedling on the left of each pair received no CIPC; that on the right received 0.05 ppm. Previous crop "treatments" as follows: 1) none 2) cucumber (susceptible) 3) squash (resistant) 4) buckwheat (susceptible).

4. When plants are grown prior to the addition of CIPC.

The results of these experiments support the hypothesis that the selective mechanism of species resistant to CIPC is due to a substance or substances produced by these species which in some way depresses the activity of the herbicide within as well as outside the plant or seed.

The author knows of no published data on plant response to CIPC that cannot be explained on the basis of the proposed "depression" hypothesis.

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BIBLIOGRAPHY OF WEED INVESTIGATIONS

for October, November, and December, 1952

PAGE

I. Economic Aspects and General Weed Problems 160

II. Botany of Weeds 160
- A. Classification and Identification 160
- B. Ecological Investigations and Surveys 160
- C. Physiological Investigations 161
- D. Morphological and Anatomical Investigations 161
- E. Weed Seed Investigations 162

III. Weed Control 162
- A. Cultural 162
- B. Chemical 162
  1. Weeds in field crops 162
  2. Weeds in horticulture, ornamental and vegetable crops 163
  3. Weeds in grasslands, including grass-legume pastures, rangeland, turf, lawns and cemeteries 163
  4. Weeds in specialized areas, including ditchbanks, canal ditches, fencerows, rights-of-way, irrigation ditches, and cities 165
  5. Woody plants 165
  6. Aquatic weeds 165
  7. Specific weeds 165
- C. Biological 166

IV. Chemical and Biochemical Investigations 166

V. Special Characteristics of Weeds 166
- A. Poisonous Plants and Their Control 166
- B. Uses of Weeds 167
- C. Pathological and Entomological Relationships 167

VI. Nature and Properties of Chemicals Used as Herbicides 167

VII. Effect of Herbicides on Soils, Livestock, and Humans 168

VIII. Equipment, Methods of application, and Herbicidal Calculations 168

IX. Legal Aspects 168

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This bibliography of current literature on weeds and their control is issued as a service to those engaged in weed research in the United States and other countries. In issuing this bibliography the Division of Weed Investigations does not assume responsibility for the subject matter cited.

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